Attached Payload Interface Requirements Document

International Space Station Program

Revision A

August 5, 2002

TYPE 1 – APPROVED BY NASA

THE INFORMATION CONTAINED IN THE “ATTACHED PAYLOAD HARDWARE INTERFACE REQUIREMENTS DOCUMENT” IS “REQUIREMENTS INTERFACE” DATA, WHICH IS CONTROLLED BY THE EXPORT ADMINISTRATION REGULATIONS (EAR) (15 CFR part 730 *et. seq.*), AND CLASSIFIED AS EAR99 UNDER THE EAR OR OTHER EXPORT CONTROL LAWS AND REGULATIONS IS PROHIBITED.

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REVISION AND HISTORY PAGE

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ERU: /s/ M. Hehn 08–30–02

INTERNATIONAL SPACE STATION PROGRAM

ATTACHED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT

PREFACE

This document defines the minimum requirements for an Attached Payload to interface to the International Space Station (ISS) and provides requirements for incorporation in the National Aeronautics and Space Administration (NASA) hardware procurements and technical programs. For the purposes of this document, an Attached Payload is defined as any scientific or technology experiment that attaches to the external unpressurized structure of the ISS. Attached Payloads can be both a unique payload package with a single scientific or technical mission, or a grouping of payloads integrated onto a larger carrier system. SSP 57003, Attached Payload Interface Requirements Document (APIRD) specifies requirements for Attached Payloads that interface to one of the six Attached Payload/Unpressurized Carrier sites located on the S3 and P3 Pre–Integrated Truss (PIT) segments, Mobile Remote Servicer Base System (MBS) Common Attach System (MCAS) and other payload locations. The APIRD contains an introduction, a list of applicable documents, subsections on general and detailed interface and payload specific design requirements, subsections on verification requirements, along with appendices containing acronyms, and definitions. This document defines interface requirements for compatibility with the ISS. The applicability of these requirements will depend upon the characteristics of the Attached Payloads as specified in the individual Payload Integration Agreement (PIA). The interface design requirements outlined in this document are mandatory and may not be violated unless specifically agreed upon in the payload unique Interface Control Document (ICD). This document is under the control of the ISS Payload Control Board (PCB) and any changes or revisions will be approved by the PCB Program Manager.

APPROVED BY:	/s/ Daniel W. Hartman	8/9/02
	Lesa B. Roe Acting Manager, Payloads Office NASA/OZ	Date

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LIST OF CHANGES

All changes to paragraphs, tables, and figures in this document are shown below:

SSCN	ENTRY DATE	CHANGE	PARAGRAPH(S)
004089	11/08/00	57003–NA–0001C	3.5.1.5.2.A, 3.5.1.5.2.B, 4.3.5.1.5.2.A, 4.3.5.1.5.2.B
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		57003–NA–0016B	3.5.1.5.3 (New), 4.3.1.5.3 (New)
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		57003–NA–0017C	3.4.1.1.5.A (New), 3.4.1.1.5.B, (New) 3.4.1.1.6.A (New), 3.4.1.1.6.B (New), 4.3.4.1.1.5.A (New), 4.3.4.1.1.5.B (New), 4.3.1.1.6.A (New), 4.3.1.1.6.B (New)
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			FIGURE(S)
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			PARAGRAPH(S)
		57003–NA–0027A	3.1.3.1.3, 3.1.3.1.3.1, 3.1.3.1.3.2, 4.3.1.3.1.3.2
			PARAGRAPH(S)
		57003–NA–0028	3.1.1.2.3, 3.5.1.12, 4.3.1.1.2.3, 4.3.5.1.12
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PARAGRAPH PAGE

APPENDIX

TABLES

TABLES (Continued)

FIGURES

FIGURES (Continued)

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1.0 INTRODUCTION

1.1 PURPOSE

This APIRD is the principle source of interface design requirements for Attached Payloads on the ISS. This APIRD will be complied with in order to certify that an external truss Attached Payload is ready for installation and operation on the ISS. NSTS 1700.7 ISS Addendum, Safety Policy and Requirements for Payloads using the ISS, and NSTS 18798, Interpretation of NSTS Payload Safety Requirements, provide the safety requirements for payload design, certification, and operation.

1.2 SCOPE

The physical, functional, and environmental design requirements associated with Attached Payload safety and interface compatibility are included herein. The requirements defined in this document apply to on–orbit phases of the Attached Payload operation. On–orbit requirements apply to all the external truss Attached Payloads of the ISS located on the Integrated Truss Assembly (ITA). Attached Payload ground handling, processing, and ground transportation requirements are specified in K–STSM–14.1, Launch Site Accommodation Handbook for Shuttle Payloads, and KHB1700.7, Space Shuttle Payload Ground Safety Handbook. Attached Payload requirements for launch, landing and payload bay interfaces are specified in NSTS 21000–IDD–ISS, Shuttle Orbiter Interface Definition Document for International Space Station and SSP 52000–PIA–TAP Payload Integration Agreement – Truss Attached Payload.

1.3 USE

This document levies design interface and verification requirements on ISS Attached Payloads. These requirements are imposed on an Attached Payload through the applicability matrix in the payload unique ICD. The payload unique ICD defines and controls the design of the interfaces between the ISS and the Attached Payload. This APIRD document serves to establish commonality with respect to interface design, analytical approaches, models, test methods and tools, technical data and definitions for integrated analysis.

1.4 EXCEPTIONS, DEVIATIONS, AND WAIVERS

The unique payload ICD documents the implementation of the APIRD requirements and ensures they remain within the interface design parameters defined by this document. Any exception to requirements, capabilities, or services defined in this APIRD shall be documented in the unique ICD. The ICD will document the specific requirement violated or excepted, a description of the existing condition, and a rationale for acceptance. Additional documentation and presentations to control boards containing cost, schedule, and technical impacts may be required for approval of deviations and waivers. SSP 57004, Attached Payload Hardware Interface Control Document

Template, provides a description of the exception submittal and approval process and the form used. The definition of exceedances, waivers and deviations are contained therein.

1.5 ENGINEERING UNITS AND TOLERANCES

Unless otherwise noted herein, all dimensions in this document are shown in the English system of inch–pound (in–lb) units. Implied tolerances on linear dimensions are defined in Table 1.5–1. Angular Tolerances are shown in Table 1.5–2. Dimensions enclosed within parenthesis are shown for reference only and provide no tolerance. Orthographic projections are constructed using the third angle projection system.

TABLE 1.5–1 LINEAR TOLERANCES

Dimensions	Tolerances
.xx	+/– .03 inches
.xxx	+/– .010 inches

TABLE 1.5–2 ANGULAR TOLERANCES

Dimensions	Tolerances
x degrees	+/– 1 degree
x degrees x minutes	+/– 0 degrees 30 minutes

2.0 DOCUMENTATION

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. Specific date and revision number of documents under control of the Space Station Control Board can be found in SSP 50257, Program Control Document Index or SSP 50258, Prime Control Document Index.

The documents in this paragraph form a part of this specification to the extent specified herein. The specific revision of each applicable document will be established at the time of baselining the unique payload ICD. In the event of a conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

2.1 APPLICABLE DOCUMENTS

DOCUMENT NO.	TITLE
ANSI X3.255	Fiber Distributed Data Interface (FDDI) – Abstract Test Suite for FDDI Physical Medium Dependent Conformance Testing (PMD ATS).
ASTM E595	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
CCSDS 301.0–B–2	CCSDS Time Code Format
CCSDS 701.0–B–2	Advanced Orbiting Systems, Network and Data Links: Architectural Specification, Blue Book
D684–10056–01	International Space Station Program, Prime Contractor Software Standards and Procedures Specification
D684–10058–03–01	Integrated ISS Thermal Math Model Volume 3 Book 1
FED–STD–595	Colors Used in Government Procurement
JSC 26557	International Space Station On–Orbit Assembly, Modeling, and Mass Properties Databook
JSC 27260	Decal Process Document and Catalog
JSC 36044	Operations Nomenclature
KHB 1700.7	Space Shuttle Payload Ground Safety Handbook
K–STSM–14.1	Launch Site Accommodation Handbook for Shuttle Payloads
MA2–99–170	Crew Mating/Demating of Powered Connectors
MIL–HDBK–5	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL–HDBK–17	Polymer Matrix Composites Vol 1 Guidelines
MIL–STD–130	Identification Marking of U.S. Military Property

DOCUMENT NO.	TITLE
MIL–STD–461	Electromagnetic Emission and Susceptibility Requirements for Control of Electromagnetic Interference
MIL–STD–462	EMI Characteristics, Measurement of
MIL–STD–1189	Standard Department of Defense Bar Code Symbology
MIL–STD–1553	Digital Time Division Command/Response Multiplex Data Bus
MIL–STD–1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Document
NASA TM 102179	Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits
NASA TM 104825	A Computer Based Orbital Debris Environment Model for Spacecraft Design and Observation in Low Earth Orbit
NSTS 07700 (VOL XIV)	Space Shuttle System Payload Accommodations
NSTS–13830	Implementation Procedure for NSTS Payloads System Safety Requirements
NSTS 1700.7B ISS Addendum	Safety Policy and Requirements for Payloads using the International Space Station
NSTS/ISS 18798	Interpretations of NSTS/ISS Payload Safety Requirements
NSTS 21000–IDD–ISS	Shuttle Orbiter Interface Definition Document for International Space Station
SD77–SH–0214	Shuttle Forcing Functions and Identification System
SN–C–0005	NSTS Contamination Control Requirements Manual
SSP 30219	Space Station Reference Coordinate System
SSP 30237	Space Station Requirements for Electromagnetic Emission and Susceptibility Requirements
SSP 30238	Space Station Electromagnetic Techniques
SSP 30240	Space Station Grounding Requirements
SSP 30242	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
SSP 30243	Space Station Requirements for Electromagnetic Compatibility
SSP 30245	Space Station Electrical Bonding Requirements
SSP 30256: 001	Extravehicular Activity Standard Interface Control Document
SSP 30420	Space Station Program Induced Plasma Environment
SSP 30425	Space Station Program Natural Environment Definition for Design
SSP 30426	External Contamination Control Requirements

DOCUMENT NO.	TITLE
SSP 30482 (V1)	Electric Power Specifications and Standards, Vol. 1: EPS Performance Specifications
SSP 30512	Ionizing Radiation Design Environment
SSP 30550	Space Station Robotic System Integration Standards Vol 1 Robotic Accommodations Requirement
SSP 30559	Structural Design and Verification Requirements
SSP 30575	Interior and Exterior Operational Location Coding System
SSP 41162	Segment Specification for the USOS
SSP 41175–02	Software ICD Part 1 Station Management and Control to ISS Book 2 General Interface Software Interfaces Requirement
SSP 42003	Space Station Manned Base to Mobile Servicing System ICD
SSP 42004	Mobile Servicing System to User (generic) Interface Control Document
SSP 50005	International Space Station Flight Crew Integration Standard (NASA STD 3000/T) Document
SSP 50007	Space Station Inventory Management System Label Specification
SSP 50014	Utility Coding Specification
SSP 50184	High Rate Data Link Physical Media, Physical Signaling & Protocol Specifications
SSP 50193	Software Interface Control Document Part 1 Payload Multiplexer/Demultiplexer to International Space Station Book 1 Hardware Architecture Interface
SSP 50254	Operations Nomenclature
SSP 52000–PIA–UPP	Payload Integration Agreement – Unpressurized Payloads
SSP 52005	ISS Payload Flight Equipment and Guidelines For Safety Critical Structures
SSP 52050	Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station
SSP 57000	Pressurized Payload Interface Requirements Document
SSP 57002	Attached Payload Software Interface Control Document Template
SSP 57004	Attached Payload Hardware Interface Control Document Template
SSP 57013	Generic Attached Payload Verification Plan
SSQ 21635, Pt. 1	Connectors and Accessories Electrical, Circular, Miniature, IVA/EVA Compatible, Space Quality, General Specification for SSP
SSQ 21637	Umbilical Mechanical Assembly Passive Half Specification

DOCUMENT NO.	TITLE
SSQ 21654	Cable, Single Fiber, Multitude, Space Quality, General Specification for Document
SSQ 21655	Cable, Electrical, MIL–STD–1553 DataBus, Space Quality, General Specification for Document
TA–92–038	Protection of Payload Electrical Power Circuits
TM–104825	A Computer Based Orbital Debris Environment Model for Spacecraft Design and Observation in Low Earth Orbit

2.2 REFERENCE DOCUMENTS

DOCUMENT NO.	TITLE
ASTM E380–86	Standard Practice for Use of the International System of Units (SI) (Modernized Metric System)
D684–10058–01	On–Orbit Integrated Thermal Analysis Report (Vol. I and II)
D684–10058–02	Plume Impingement Heat Rate Report
ISO/IEC 8802–3	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
MDC 02H1044	Common Attach System (CAS) Interface Class R Bonding Test Report
MIL–HDBK–1553	Digital Time Division Command/Response Multiplex Data Bus Handbook
MIL–STD–1522	Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems
MIL–STD–1246	Military Standard Product Cleanliness Levels and Contamination Control Program
MSFC–SPEC–250	Protective Finished for Space Vehicle Structures and Associated Flight Equipment, General Specification for Document
MSFC–STD–275	Marking of Electrical Ground Support Equipment, Front Panels, and Rack Title Plates
NSTS 14046	Payload Verification Requirements
SID79K12170	Payload Ground Handling Mechanism
SID79K18218	Multi–Mission (MMSE) Transportation Canister
SP–M–229	Addendum Specification to Prime Item Development Specification for Integrated Truss Element P3 for Integrated Truss Segment (ITS) S3
SP–M–235	Prime Item Development Specification for Integrated Truss Segment P3
SS–VE–009	Materials Identification and Usage List
SS–VE–010	Materials Usage Agreement
SSP 30233	Space Station Requirements for Material and Processes

SSP 30312	Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan for Space Station Program
SSP 41000	System Specification for the International Space Station
SSP 41175–08	Software ICD Part 1 Station Management and Control to ISS Book 2 General Interface Software Interfaces Requirement
SSP 42125	Integrated Truss Segment P1 to Integrated Truss Segment P3 ICD
SSP 42128	Integrated Truss Segment S1 to Integrated Truss Segment S3 ICD
SSP 42131	Integrated Truss Segments P3 and S3 to Attached Payloads and Unpressurized Cargo Carriers ICD
SSP 44025	Integrated Truss Segment S3 to Integrated Truss Segment S4 ICD
SSP 44026	Integrated Truss Segment P3 to PVM P4 ICD
SSP 50006	Caution and Warning Labels
SSP 50023	Thermal Control Plan
SSP 50200–8	Station Program Implementation Plan Vol. VIII, Increment Execution Preparation
SSP 50228	Station Configuration and Assembly Pressurized Mating Adapter 2, 3 Standard ICD
SSP 50257	Program Control Document Index
SSP 50258	Prime Control Document Index
SSP 57026	Process for Exception to Hardware Interface Requirement
STM 0006	Coating, Thermal Control, Potassium Silicate – Zinc Oxide
STP 0016	Coating, Thermal Control, Potassium Silicate – Zinc Oxide, Application of

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3.0 INTERFACE REQUIREMENTS

3.1 STRUCTURAL/MECHANICAL AND MICROGRAVITY INTERFACE REQUIREMENTS

This section defines the structural/mechanical and microgravity requirements between ISS Attached Payloads and the ISS locations that may be used for Attached Payloads.

3.1.1 GENERAL DESIGN REQUIREMENTS

Attached Payload hardware design drawings, exceedances, deviations, waivers, and engineering change requests shall reflect the as–built hardware.

3.1.1.1 SAFETY CRITICAL STRUCTURES

3.1.1.1.1 FAIL—SAFE, SAFE—LIFE, OR LOW—RISK FRACTURE PARTS

Attached Payload structure shall be designed to be fail—safe, have safe—life, or be a low—risk fracture part in accordance with SSP 52005, ISS Payload Flight Equipment and Guidelines for Safety Critical Structures, section 5.0.

3.1.1.1.2 FRACTURE CONTROL

The Attached Payload shall meet the fracture control requirements in accordance with SSP 52005, section 5.3, for the on orbit interfaces with a PAS/UCCAS site.

3.1.1.1.3 METEOROID AND ORBITAL DEBRIS PROTECTION REQUIREMENT FOR EXTERNAL PAYLOADS

An Attached Payload that is a stored energy device, contains a stored energy device (examples: pressure vessels, cryogenic carriers, flywheels), or contains any other hardware that could create a catastrophic hazard if impacted or penetrated by a meteoroid or orbital debris particle shall be designed to SSP 52005, paragraph 5.1.5 and NASA TM 104825, A Computer Based Orbital Debris Environment Model for Spacecraft Design and Observation in Low Earth Orbit.

3.1.1.2 INTERFACE LOADS

3.1.1.2.1 MARGINS OF SAFETY

Attached Payloads shall provide positive margins of safety when exposed to crew induced loads and for on–orbit loads in accordance with SSP 52005, section 5.2.

3.1.1.2.2 FACTOR(S) OF SAFETY

Safety factors for Attached Payload structural design shall be in accordance with SSP 52005, section 5.1.

3.1.1.2.3 DESIGN LOADS

A. Attached Payload structures and systems shall be designed in accordance with SSP 30559, paragraph 3.2 and the loads referenced in Table 3.1.1.2.3–1. The PAS/UCCAS interface shall be designed to withstand the interface loads in Table 3.1.1.2.3–2 combined with the preload defined in paragraph 3.1.3.1.3.1 and the thermal loads derived from the environment defined in paragraph 3.5.1.12. The associated on–orbit transient load spectra are defined in Table 3.1.1.2.3–3 and Table 3.1.1.2.3–4.

B. When the payload is coupled to the ISS attachment structure, the AP/UCC interface loads shall not exceed those specified in Table 3.1.1.2.3–2. (The interface loads in Table 3.1.1.2.3–2 were derived to envelope AP/UCC that are within the mass and center of gravity limits defined in paragraph 3.1.3.1.2.2)

TABLE 3.1.1.2.3–1 STRUCTURAL DESIGN LOADS

Document	Paragraph	Description
NSTS 21000-IDD-ISS	14.4.5	SRMS Interface Loads (coupled)
NSTS 21000-IDD-ISS	14.4.1.6	SRMS Impact Load
SSP 42004	I.3.2.2.3	SSRMS Structure Static Loads Requirement
SSP 42004	C.3.2.2.3	User Structural Interface (Orbital Replacement Unit (ORU)/Tool Changeout Mechanism to User)
SSP 42004	C.3.2.2.3.1	Impact Energy (ORU/Tool Changeout Mechanism to User)
SSP 42004	A.3.2.2.3	User Structural Interface (Power and Data Grapple Fixture (PDGF))
SSP 42004	A.3.2.2.3.1	Impact Energy (PDGF)

TABLE 3.1.1.2.3–2 PAYLOAD TO PAS INTERFACE LOADS (LATCH ENGAGED)

Condition	Fx (lbs)	Fy (lbs)	Fz (lbs)	Mx (lbs in)	My (lbs in)	Mz (lbs in)
1	+420.	+40.	–70.	–4620.	–32,370.	–6140.
2	–410.	–50.	+70.	–4770.	+33,740.	–10,710.
3	–250.	–640.	+120.	+51,870.	+19,620.	+2610.
4	+250.	+640.	–120.	–51,870.	–19,620.	–2610.
5	–190.	+100.	–480.	–15,800.	+14,300.	+3070.
6	+190.	+100.	+490.	–7780.	–14,440.	+4370.
7	–520.	–180.	+90.	–14,390.	+43,410.	–18,850.
8	+210.	+510.	–10.	+38,990.	–9,200.	+25,610.

Note(s):
1) Loads are defined in the PAS/UCCAS coordinate system as shown in Figure 3.1.3.1.2.1–1.
2) Interface loads are summed about the centerline of the AP/UCC capture bar.
3) The interface is designed for combined preload (no gapping) and thermal loads.
4) Loads due to on–orbit events with respect to load/cycle spectra in Table 3.1.1.2.3–3.
5) For analysis purposes these loads are applied from the AP/UCC through the mating interface.
6) Loads derived from analysis evaluating all six CAS locations. Specifically, these values represent the worst case loads at the UCCAS #1 (P3, Face 3) location. The magnitude of these values have been adjusted to account for the orientation differences between the ISS coordinate system and the UCCAS #1 location. They can therefore be independently applied at each of the six CAS locations. For reference, the orientation differences between the ISS coordinate system and the UCCAS #1 local coordinate system are Y = –Y and Z = –Z.

TABLE 3.1.1.2.3–3 MECHANICAL LOAD SPECTRA FOR ON–ORBIT EVENTS

Service Life Event and Applicability	Percent of Internal Limit Loads Derived Using Design Load For Event	Cycles At Percent Of Load Level
Preload [1, 2]	100	60
Berthing Load Spectra [1, 3]	100	34
(Latch disengaged)	80	34
	60	60
	40	179
Operational Load Spectra [4]	100	352
Latched + EVA/misc events)	80	1242
	60	7211
	40	29366
	20	188025

TABLE 3.1.1.2.3–4 THERMAL LOAD SPECTRA FOR ON–ORBIT EVENTS

Service Life Event and Applicability	Percent of Internal Limit Loads Derived Using Thermal Load	Cycles At Percent Of Load Level
Thermal Spectra [5]	100	150
	90	250
	80	500
	70	5000
	60	50000
	50	30000
	40	20000
	30	5100

Notes:
1) The load/cycle spectra is based upon the PAS/UCCAS active half design requirement of 60 loaded cycles over a 10 year period.
2) Reference section 3.1.3.1.3.1 for interface preload.
3) Reference section 3.1.1.2.4 for berthing contact loads.
4) Reference Table 3.1.1.2.3–2 for interface operational loads.
5) Reference section 3.5.1.2 for the thermal environment.

3.1.1.2.4 PAYLOAD BERTHING

3.1.1.2.4.1 GUIDE PIN CONTACT FORCES

Attached Payloads shall withstand berthing contact forces at guide pins based on a robotic installation approach speed of 0.1 ft/second (sec) and berthing contact conditions as specified in Table 3.1.1.2.4.1–1. All forces are provided with directions referenced per Figure 3.1.3.1.2.1–1.

TABLE 3.1.1.2.4.1–1 PAYLOAD TO PAS BERTHING CONTACT FORCES (LBS) – LATCH DISENGAGED

Case	Guide Pin1			Guide Pin 2			Guide Pin 3		
	Fx	Fy	Fz	Fx	Fy	Fz	Fx	Fy	Fz
1	0.	0.	0.	–365.	–331.	601.	65.	0.	0.
2	0.	0.	0.	365.	–331.	601.	65.	0.	0.
3	0.	0.	0.	–486.	0.	522.	80.	703.	757.
4	0.	0.	0.	486.	0.	522.	80.	703.	757.
5	0.	0.	0.	–486.	0.	522.	80.	–703.	757.
6	0.	0.	0.	486.	0.	522.	80.	–703.	757.
7	0.	535.	574.	0.	–616.	0.	204.	0.	0.
8	0.	–535.	574.	0.	–616.	0.	204.	0.	0.
9	–156.	0.	0.	0.	0.	0.	0.	0.	0.

3.1.1.2.4.2 CAPTURE BAR CONTACT FORCES

The Attached Payload capture bar shall withstand the maximum berthing contact forces as defined in Table 3.1.1.2.4.2–1.

TABLE 3.1.1.2.4.2–1 CAPTURE BAR IMPACT LOAD (LBS)

Fx	Fy	Fz
+/– 526	+/– 233	539

Note(s):
1) Forces are defined in the PAS/UCCAS coordinate system as shown in Figure 3.1.3.1.2.1–1.
2) These values are based upon the AP/UCC Capture Bar impacting the CLA Claw during normal berthing operations.

3.1.1.2.5 THERMAL EFFECTS

Attached Payload structure shall meet interface requirements when subjected to structural interface temperatures ranging from –120 degrees F to +200 degrees F when combined with static and dynamic loads.

3.1.1.2.6 EXTRAVEHICULAR ACTIVITY ON—ORBIT INDUCED LOADS

EVA on–orbit induced loads for inadvertent kick and kick–off, push–off loads do not apply to hardware or worksites which are assembled or maintained using robotic systems. External components of Attached Payload hardware which will have a crew or crew actuated tool interface(s) shall withstand the loads defined in Table 3.1.1.2.6–1 and 3.1.1.2.6–2.

TABLE 3.1.1.2.6–1 EXTRAVEHICULAR ACTIVITY INDUCED LOADS

Design Limit Load Type	Limit Load	Type of Loading	Direction	Category of Structure	Application Comments
Force Application (EVA Handling Load)	45 pounds force (lbf) (35 in—lbf for connector panels for mate/demate of connector)	Quasi—static concentrated load over a 1.25 inch radius circular area.	Any direction	ORUs and non–structural closures and covers (including shields, cables, cable connector brackets, cable connector panels, cable clamps)	This load can be applied anytime to any hardware by the EVA crewmember when in a foot restraint
EVA Kick–Off, Push–Off Force of Tethered Crewmember	200 lbf	Quasi–static concentrated load over a 3.0 inch diameter circular area at worst location	Perpendicular to and directed toward surface	All primary and secondary structure inside or near (within 24 inch) a translation path or worksite	This maximum kick–off or push–load applies where the crewmember is using the hardware to provide a reaction point during translation
Inadvertent kick, bump	125 lbf	Quasi–static concentrated load over a 0.5 inch diameter circular area	Any direction	Secondary structure near (within 24 in.) translation path or worksite	This is an accidental impact. It should be applied to hardware near (within 24 inches) translation paths and worksites
EVA load for design of PFR supporting structure	274 lbf shear; 4200 in–lb bending moment in torsion	Quasi–static load applied at PFR socket to structure interface	Force in any direction; moment about any axis	All structure on which a foot restraint is attached	Force and moment applied simultaneously
EVA tool tether attach point	75 lbf	Concentrated load—pull (tension)	Any direction	Any structures supporting tool tether attach points	
Tool Impact	125 lbf	Concentrated load on a 0.06 inch radius circular area	Any direction	Windows and exposed glass	

Note: EVA on orbit induced loads for inadvertent kick and kickoff, pushoff loads do not apply to hardware or worksites which are assembled or maintained using robotic system.
DAC8 analysis completed 2/1/00 proved that the EVA loads are less than PAS interface loads in SSP 42131; therefore the EVA maneuvers are acceptable on attached payloads.

TABLE 3.1.1.2.6–2 MISCELLANEOUS CREW ACTUATION LOAD LIMITS

Crew System	Type of Load	Limit Load	Direction of Load
Tool design • Fine motor activity with gloved hand (no tools used) • Gross motor skills with low loads (tool operations)	Concentrated load Concentrated load	< 5 lb force (< 40 in–oz torque) < 20 lb force (< 24 ft lb torque)	Any direction Any direction
EVA mechanical resistive force	Concentrated load	> 3.5 lb	Any direction
EVA hatches/doors/covers	Concentrated load	< 25 lb (latch mechanism) < 45 lb (opening/closing hatch/door/covers)	Any direction
EVA connectors	Concentrated load	< 35 in–lb (mate/demate)	Torque
Mounting hardware (install/remove) (EVA)	Concentrated load	< 35 lb	Any direction
High Torque fasteners (without torque reaction interfaces)	Concentrated load	< 25 ft–lb	Torque
High Torque fasteners (with torque reaction interfaces)	Concentrated load	< 100 ft–lb	Torque

3.1.1.3 DESIGN SERVICE LIFE

For the purposes of conducting structural analysis for the interface to the PAS/UCCAS, the service life shall be the maximum expected on–orbit life plus two years.

3.1.1.4 OPERATIONAL LIFETIME

The PAS/UCCAS interface will have an operational lifetime of the maximum expected on–orbit life plus two years given periodic inspections, preventive and corrective maintenance, restoration, replacement of components, and re–supply operations.

3.1.1.5 INTERCHANGEABILITY

Attached Payloads shall be compatible with contingency installation and safety related operations on any one of the six PAS/UCCAS site locations.

3.1.1.6 ATTACHED PAYLOAD INTERFACE DURABILITY

Attached Payloads shall withstand a minimum of 6 combined mate and demate cycles per year combined with the MCAS, PAS, or UCCAS attach sites.

3.1.1.7 STRUCTURAL MATERIALS CRITERIA AND SELECTION

A. Mechanical properties of Attached Payload structural materials shall be in accordance with MIL–HDBK–5, Metallic Materials and Elements for Aerospace Vehicle Structures, and MIL–HDBK–17, Polymer Matrix Composites Vol 1 Guidelines.

B. Attached Payload structural material selection shall be in accordance with NSTS 1700.7, ISS Addendum paragraph 208.3.

3.1.1.8 STRUCTURAL DEGRADATION FROM MATERIAL EROSION

Potential structural erosion, e.g., plasma environmental effects compatibility–induced, atomic oxygen (AO) during the design life and exposure to the environment as defined in SSP 30425, Space Station Program Natural Environment Definition for Design, shall be included in the design and analysis of the Attached Payload structure.

3.1.2 STRUCTURAL/MECHANICAL INTERFACE WITH THE MOBILE SERVICING SYSTEM

The Attached Payload to Mobile Servicing System (MSS) interface provides structural support for the Attached Payload while attached to the Mobile Remote Servicer (MRS) Base System (MBS) Common Attach System (MCAS). This interface allows the Attached Payload to be transported along the ISS truss to and from the six Integrated Truss Segment (ITS) S3/P3 attach sites. The MCAS also provides access to power and data resources from the United States On–orbit Segment (USOS) via an Umbilical Mechanism Assembly (UMA) while the MSS is parked and utilizing a truss utility port. The mechanical interface between the Attached Payload and the MCAS, physically similar to the interface with the Payload Attach System/Unpressurized Cargo Carrier Attach System (PAS/UCCAS) sites, must meet the requirements defined in SSP 42004, Mobile Servicing System to User (generic) Interface Control Document Parts 1 and 2, Section B3.

3.1.2.1 STRUCTURAL DESIGN INTERFACE

Attached Payloads shall structurally interface with the MCAS as specified in SSP 42004, paragraph B3.2.2.3.

3.1.2.2 MECHANICAL DESIGN INTERFACE

The Attached Payload shall mechanically interface with the MCAS as specified in SSP 42004, paragraph B3.2.2.2.

3.1.2.3 MASS AND ENVELOPE DIMENSIONS

A. The total mass of the Attached Payload (facility carrier & payload experiments) to be attached at the MCAS translated by the Mobile Transporter (MT) along the ISS truss shall not exceed 19000 lbs.

Note: The capability of the MCAS site is reduced to 10,000 lbs during Russian dockings.

B. The Attached Payload (facility carrier & payload experiments) shall not exceed the MCAS user envelope dimensions of SSP 42004, paragraph B3.2.2.1.

3.1.3 STRUCTURAL/MECHANICAL INTERFACE WITH THE INTEGRATED TRUSS SEGMENT S3 PAYLOAD ATTACH SYSTEM AND INTEGRATED TRUSS SEGMENT P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

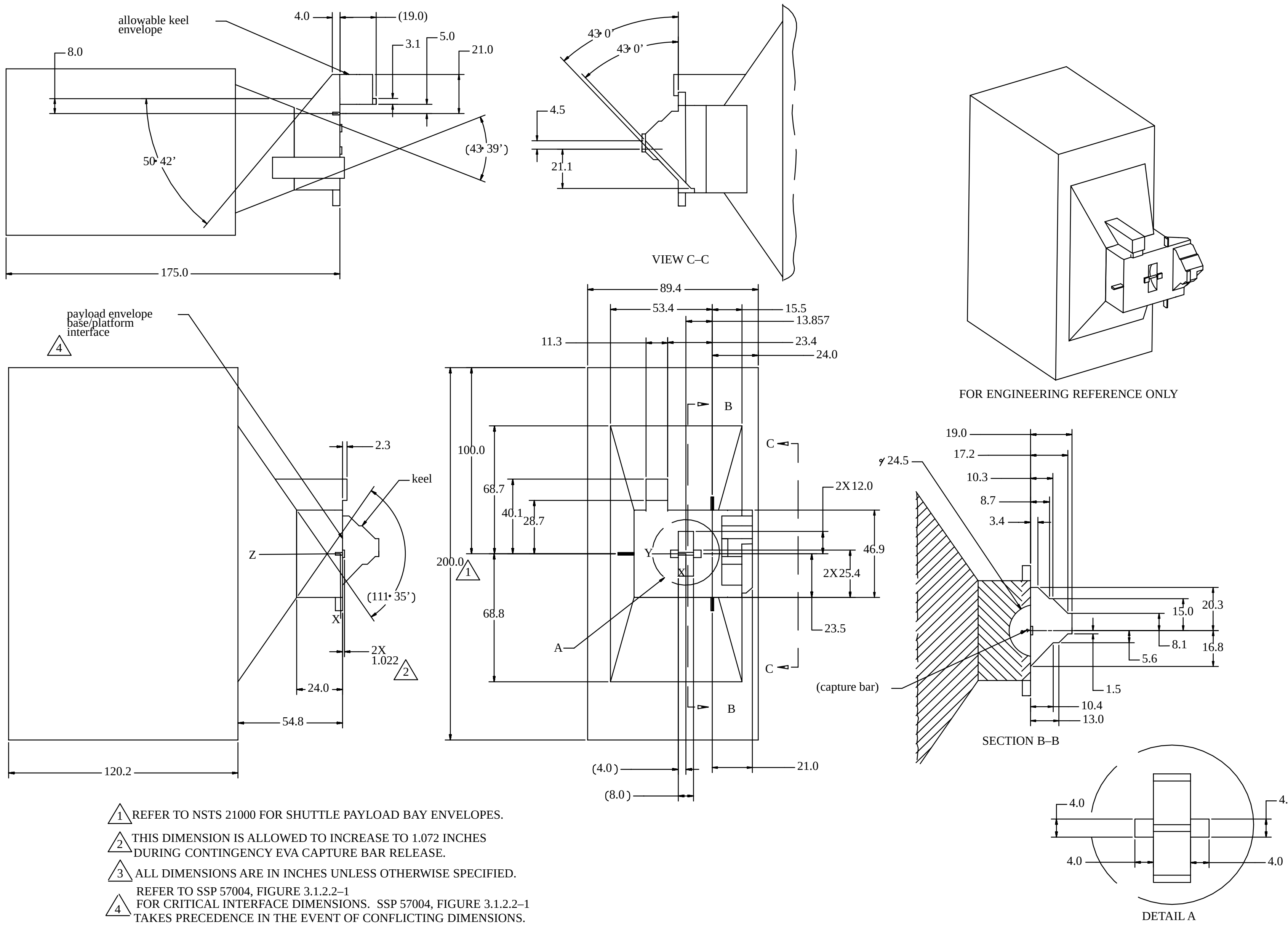
The mechanical interface between the Attached Payload and the truss segment on–orbit is through a PAS or UCCAS. The PAS/UCCAS provides a capture latch and guide vane structural interface and supports the UMA for the USOS power and data interface. The Attached Payloads to the PAS/UCCAS/MCAS interface allows transmittal of loads, and provides electrical, data, and mechanical interfaces.

3.1.3.1 STRUCTURAL/MECHANICAL

3.1.3.1.1 PHYSICAL ENVELOPE REQUIREMENTS

3.1.3.1.1.1 PAYLOAD ATTACH SYSTEM /UNPRESSURIZED LOGISTICS CARRIER ATTACH SYSTEM ON–ORBIT OPERATIONAL ENVELOPE

Attached Payloads and equipment shall be designed such that the payload does not exceed the allowable on–orbit operational envelope in accordance with Figure 3.1.3.1.1.1–1.



1 REFER TO NSTS 21000 FOR SHUTTLE PAYLOAD BAY ENVELOPES.

2 THIS DIMENSION IS ALLOWED TO INCREASE TO 1.072 INCHES DURING CONTINGENCY EVA CAPTURE BAR RELEASE.

3 ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.

4 REFER TO SSP 57004, FIGURE 3.1.2.2–1 FOR CRITICAL INTERFACE DIMENSIONS. SSP 57004, FIGURE 3.1.2.2–1 TAKES PRECEDENCE IN THE EVENT OF CONFLICTING DIMENSIONS.

FIGURE 3.1.3.1.1.1–1 OPERATIONAL ENVELOPE

This envelope includes distortions due to thermal environments and allocates clearance for S3/P3 secondary translation paths when the Attached Payload is in the berthed position.

3.1.3.1.1.2 INTERFACE PLANE PROTRUSION

Attached Payloads shall be designed to ensure that no structural, mechanical, utility or ORU component protrudes past the PAS/UCCAS interface plane as defined by the X/Y plane in Figure 3.1.3.1.2.1–1, except for capture bars and envelope for Attached Payload trunnion.

3.1.3.1.1.3 EXTRAVEHICULAR ACTIVITY/ROBOTICS OPERATIONAL ENVELOPE

A. Extravehicular Activity (EVA) translation corridor and accessibility shall be maintained between the Attached Payload and other ISS equipment, including Attached Payloads or other installations on adjacent PAS/UCCAS sites, in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA STD 3000/T) document, paragraph 14.5.

B. Robotic translation corridor and accessibility shall be maintained around the operational/deployed Attached Payload for ISS operations and the installation/removal of Attached Payloads or other installations on adjacent PAS/UCCAS sites in accordance with SSP 41162, paragraph 3.2.2.7.

3.1.3.1.2 MASS PROPERTIES AND CENTER OF GRAVITY

3.1.3.1.2.1 PAYLOAD ATTACH SYSTEM COORDINATE SYSTEM ORIGIN LOCATION

Attached Payloads shall use the PAS local coordinate system origin location defined in Figure 3.1.3.1.2.1–1.

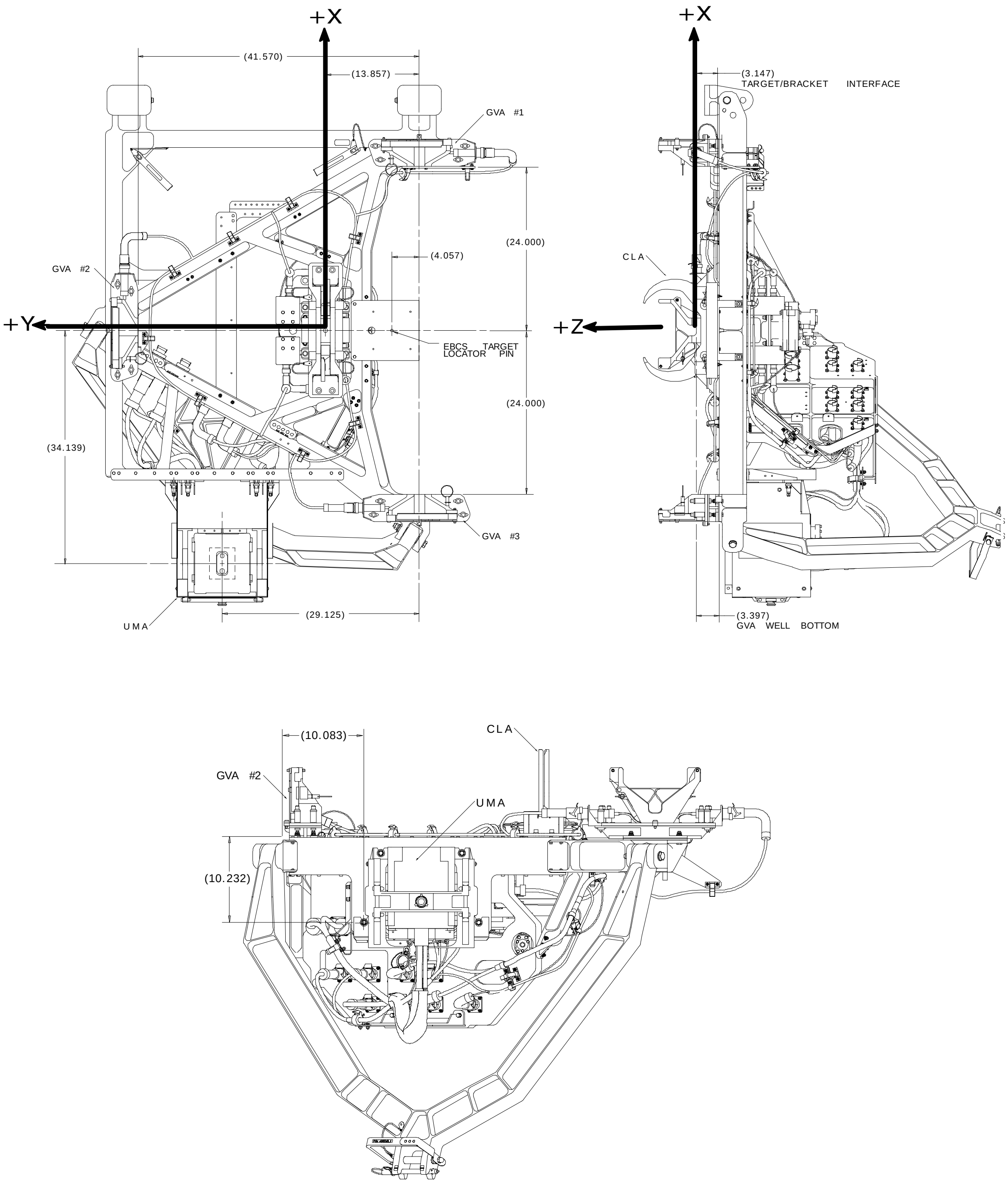


FIGURE 3.1.3.1.2.1–1 PAS LOCAL COORDINATE SYSTEM ORIGIN LOCATION

3.1.3.1.2.2 MASS AND CENTER OF GRAVITY

For Attached Payloads between the masses of 3000 lbs and 19000 lbs the allowable center of gravity offsets shall be as follows:

A. 3000 lbs: X +/– 32 inches, Y +/– 32 inches, Z between 0 and +100 inches

B. 19,000 lbs: X +/– 32 inches, Y +/– 32 inches, Z between 0 and + 66 inches.

All dimensions are with respect to the PAS local coordinate system as defined in Figure 3.1.3.1.2.1–1. It is acceptable to linearly interpolate between the maximum and minimum payload weights and CG positions.

3.1.3.1.3 ATTACHED PAYLOAD FUNDAMENTAL FREQUENCY

The Attached Payload in its on–orbit configuration will provide adequate interface stiffness to meet a minimum fundamental frequency requirement. The Attached Payload shall exhibit a minimum fundamental frequency of 1.5 Hz or greater when rigidly fixed in all 6 degrees of freedom at the PAS/UCCAS interface points defined in 3.1.3.1.3.2.

3.1.3.1.3.1 INTERFACE PRELOAD

The Attached Payload shall be capable of providing a minimum and maximum loading in the –Z direction of 4900 lbs and 6430 lbs, respectively. Loads will be applied by the CLA to the Capture Bar as the Attached Payload is pulled toward the Active Half as shown in Figure 3.1.2.3–1 of SSP 57004, Attached Payload Hardware Interface Control Document Template. For analysis purposes, this load is to be applied at the midpoint of the Capture Bar at PAS coordinates X =0, Y=0, Z=1.142. Note that the stated Z location is for the unloaded condition.

3.1.3.1.3.2 INTERFACE STIFFNESS

The stiffness of the Attached Payload interface in the z direction shall be 13500 +/– 10% lbf/in. This stiffness is measured with the Attached Payload Guide Pins simply supported on the Guide Vane Assemblies while a preload is applied per 3.1.3.1.3.1. For analysis purposes, the following Guide Pin to Guide Vane Assembly reaction points may be used:

	Reaction Point in PAS Coordinates (X, Y, Z)	Constrained DOF
Guide Vane 1	(24.000, – 13.857, 0.000)	TY, TZ
Guide Vane 2	(0.000, 27.713, 0.000)	TX, TZ
Guide Vane 3	(–24.000, –13.857, 0.000)	TY, TZ

Note: “T” designates translation in the direction specified.

3.1.3.2 MECHANICAL INTERFACE

The mechanical interface between the on orbit Attached Payload and the truss segment is through a PAS or UCCAS. Each attach system active half provides three Guide Vane Assemblies and a Capture Latch Assembly for the structural interface and supports a UMA for the power and data interface. The Attached Payload PAS/UCCAS passive half interface consists of five contacting surfaces including the three Guide Pins, the Capture Bar, and the UMA Passive Half. In addition, an External Berthing Camera System (EBCS) camera will support the SSRMS berthing operations. The Attached Payload mechanical interface to the PAS on or UCCAS is defined in SSP 57004, Attached Payload Hardware ICD Template, paragraph 3.1.2.

3.1.3.2.1 EXTRAVEHICULAR ACTIVITY RELEASABLE AND REMOVABLE CAPTURE BAR

A. The Attached Payload design shall include an EVA releasable and removable capture bar to interface with the PAS/UCCAS Capture Latch Assembly (CLA) with provisions per SSP 30256:001 allowing operation by EVA. The Attached Payload mechanical interface to the PAS/UCCAS is defined in SSP 57004, paragraph 3.1.2.2.

B. EVA releasable and removable capture bar design, location, and tolerances shall be in accordance with SSP 57004, Figure 3.1.2.2–1.

C. The design of the Attached Payload EVA releasable and removable capture bar shall allow elimination of preload and the subsequent removal and reinstallation of the capture bar. The EVA releasable and removable capture bar must be capable of releasing the entire deflection of both the passive and active PAS/UCCAS. Based on the stiffness defined in section 3.1.3.1.3.2, an interface preload as defined in 3.1.3.1.3.1, and a combined interface stiffness of 9400 lbf/in, the passive PAS shall be capable of a 0.71 inch stroke in releasing preload.

3.1.3.2.2 GUIDE PINS

A. The Attached Payload shall have three guide pins for interface to the PAS/UCCAS guide vanes. The Attached Payload mechanical interface to the PAS/UCCAS is defined in SSP 57004.

B. Guide pins design, location, and tolerances shall be in accordance with SSP 57004, Figure 3.1.2.2–1.

3.1.3.2.3 PASSIVE UMBILICAL MECHANISM ASSEMBLY

The Attached Payload passive UMA must meet the following:

A. The Attached Payload shall use the passive UMA part number 1F70162–1, to interface to the PAS/UCCAS UMA active half. The Attached Payload mechanical interface to the PAS/UCCAS is defined in SSP 57004, paragraph 3.1.2.

B. The passive UMA shall be accessible for manual EVA backup operation and EVA removal in accordance with SSP 50005, paragraph 12.3.

3.1.3.2.3.1 PASSIVE UMA MOUNTING

A. The Attached Payload developer shall locate the passive UMA on the payload structure as defined in SSP 57004, Figure 3.1.2.2–1.

B. The interface for the attachment of the passive UMA shall be designed to withstand a 100 lbf interface load in any direction at 5.49 in. below (–Z) and centered between the (4) UMA structural attachment bolt centerlines. This load will be applied to the structure during engagement operations with the active UMA. **(TBR #11)**

C. The UMA mounting interface as defined in SSP 57004, Figure 3.1.2.2–1, shall meet or exceed the stiffness specified in Table 3.1.3.2.3.1–1. This stiffness is measured with the passive half of the PAS simply supported on the guide pins with the capture bar preloaded per 3.1.3.1.3.1 while a load is applied at 5.49 in. below (–Z), and centered between, the (4) UMA structural attachment bolt centerlines. **(TBR #11)**

D. The Attached Payload shall be designed to maintain the UMA passive half within its on–orbit operating temperature range of –90° F to +190° F.

TABLE 3.1.3.2.3.1–1 UMA PASSIVE HALF MOUNTING BRACKET STIFFNESS

Translation lb/in			Rotation in–lb/rad		
X	Y	Z	X	Y	Z
5,000	6,500	5,000	2,200,000	700,000	4,200,000

Note: Loads are defined in the PAS/UCCAS coordinate system as shown in Figure 3.1.3.1.2.1–1.

3.1.3.2.4 MECHANICAL STOP DESIGN

Attached Payloads and associated equipment must be designed in such a manner to ensure that gimbaled and other mechanical actuating devices have mechanical stops so as to not exceed the intended limits of travel.

A. Mechanical stops shall be designed with the mechanical strength necessary to absorb the maximum expected energy when contact is made, using factors of safety defined in SSP 52005, section 5.0.

B. Mechanical stops shall be designed for four times the number of duty cycles expected in operational use, including duty cycles encountered during testing.

3.1.3.2.5 SAFETY INTERLOCKS

Safety interlocks shall be provided to protect against unsafe operations when access to Attached Payload equipment is required for on orbit maintenance.

3.1.3.2.6 MICROGRAVITY

Microgravity requirements are defined to limit the disturbing effects of Attached Payloads on the microgravity environment of other payloads during microgravity mode periods. These requirements are separated into the quasi–steady category for frequencies below 0.01 Hz, the vibratory category for frequencies between 0.01 Hz and 300 Hz, and transients. For attached payloads, the microgravity payload interface is between the TRUSS mounted attachment system and EXPRESS Pallet or other attached payload. The areas that are to be protected from attached payload disturbances are the pressurized volume of the APM, JEM and USL.

3.1.3.2.6.1 LIMIT QUASI–STEADY ACCELERATIONS

For frequencies below 0.01 Hz, Attached Payloads shall limit unbalanced translational average impulse to generate less than 10 lb–s (44.5 N–s) within any 10 to 500 second period, along any ISS coordinate system vector.

3.1.3.2.6.2 LIMIT VIBRATORY AND TRANSIENT ACCELERATIONS

3.1.3.2.6.2.1 VIBRATORY REQUIREMENTS

Between 0.01 and 300 Hz, payloads shall limit vibration so that the acceleration limits of Figure 3.1.3.2.6.2.1–1 (Table 3.1.3.2.6.2.1–1) are not exceeded using simultaneously the force transfer functions of Figures 3.1.3.2.6.2.1–2 and 3.1.3.2.6.2.1–4 (Tables 3.1.3.2.6.2.1–2 and 3.1.3.2.6.2.1–4) and the moment transfer function of Figures 3.1.3.2.6.2.1–3 and 3.1.3.2.6.2.1–5 (Tables 3.1.3.2.6.2.1–3 and 3.1.3.2.6.2.1–5).

For each attached payload disturbance, the interface forces shall be resolved into an equivalent set of forces and moments about the capture latch of the attached payload to ISS interface. The root–sum–square acceleration response shall then be calculated with the transfer functions or an approved surrogate for each resolved force and moment component. The total acceleration for compliance evaluation per Figure 3.1.3.2.6.2.1–1 is then the root–sum–square of these. Each one–third octave value will be calculated for the worst case 100 second interval amplitude. Sources that are locked in a fixed phase relationship by design shall be modeled with correct phase. Sources that have random phase or drift in and out of phase may be treated as non–synchronous sources.

The forces within each 1/3 octave band will be classified as either wide–band or narrow–band. Forces will be classified as wide–band if the peak–to–average ratio is less than or equal to five, otherwise they will be classified as narrow–band. The peak to average ratio will be determined by dividing the peak power spectrum magnitude of the one–third octave band by the average magnitude within the band for the axis in which the peak occurs. The classification will be used to determine the appropriate transfer function to apply to interface forces for each 1/3 octave band. The resulting accelerations shall not exceed the acceleration limit of Figure 3.1.3.2.6.2.1–1.

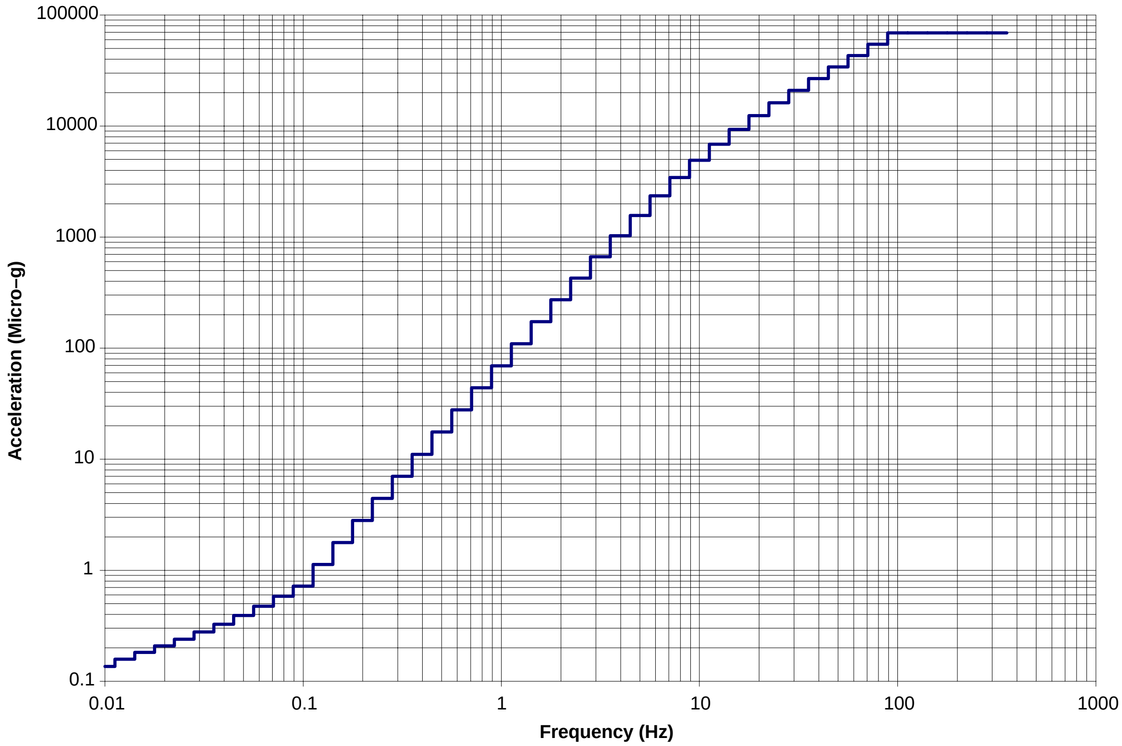


FIGURE 3.1.3.2.6.2.1–1 MICROGRAVITY ACCELERATION CONTRIBUTION LIMIT FOR AN ATTACHED PAYLOAD

TABLE 3.1.3.2.6.2.1–1 MICROGRAVITY ACCELERATION CONTRIBUTION LIMIT VALUES FOR AN ATTACHED PAYLOAD

Freq (Hz)	micro–g	Freq (Hz)	micro–g	Freq (Hz)	micro–g
0.01	0.135795	0.25119	4.429314	6.3096	2347.353
0.012589	0.135795	0.31623	4.429314	7.9433	2347.353
0.012589	0.15828	0.31623	7.00535	7.9433	3441.949
0.015849	0.15828	0.39811	7.00535	10	3441.949
0.015849	0.182353	0.39811	11.08582	10	4922.221
0.019953	0.182353	0.50119	11.08582	12.589	4922.221
0.019953	0.208846	0.50119	17.54832	12.589	6856.618
0.025119	0.208846	0.63096	17.54832	15.849	6856.618
0.025119	0.239791	0.63096	27.77789	15.849	9316.433
0.031623	0.239791	0.79433	27.77789	19.953	9316.433
0.031623	0.278137	0.79433	43.95909	19.953	12391.21
0.039811	0.278137	1	43.95909	25.119	12391.21
0.039811	0.327408	1	69.52806	25.119	16204.62
0.050119	0.327408	1.2589	69.52806	31.623	16204.62
0.050119	0.391535	1.2589	109.8586	31.623	20929.12
0.063096	0.391535	1.5849	109.8586	39.811	20929.12
0.063096	0.474943	1.5849	173.3039	39.811	26795.8
0.079433	0.474943	1.9953	173.3039	50.119	26795.8
0.079433	0.582712	1.9953	272.6872	50.119	34102.98
0.1	0.582712	2.5119	272.6872	63.096	34102.98
0.1	0.72102	2.5119	427.3361	63.096	43236.43
0.12589	0.72102	3.1623	427.3361	79.433	43236.43
0.12589	1.129798	3.1623	665.6667	79.433	54674.49
0.15849	1.129798	3.9811	665.6667	100	54674.49
0.15849	1.777325	3.9811	1027.688	100	69029.68
0.19953	1.777325	5.0119	1027.688	300	69029.68
0.19953	2.803515	5.0119	1566.557		
0.25119	2.803515	6.3096	1566.557		

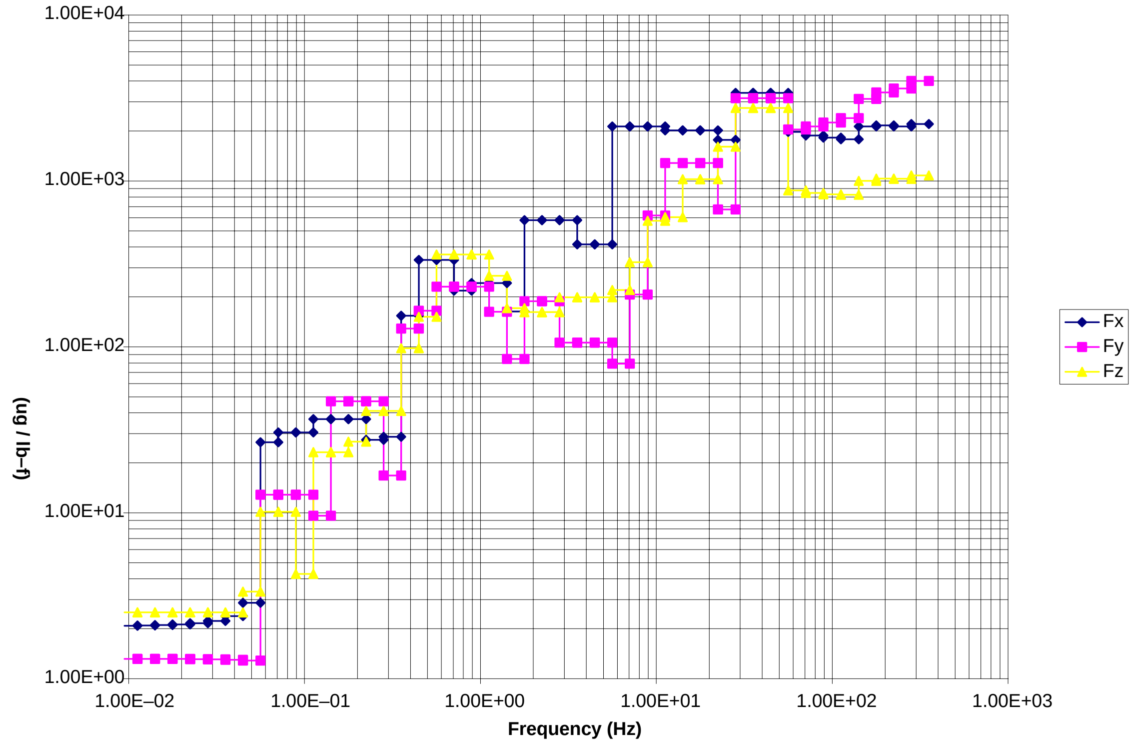


FIGURE 3.1.3.2.6.2.1–2 ONE–THIRD OCTAVE NARROW–BAND FORCE TRANSFER FUNCTIONS FOR ATTACHED PAYLOADS

TABLE 3.1.3.2.6.2.1–2 ONE–THIRD OCTAVE NARROW–BAND FORCE TRANSFER FUNCTIONS FOR ATTACHED PAYLOADS

Frequency (Hz)	Fx	Fy ug/lb–f	Fz	Frequency (Hz)	Fx	Fy ug/lb–f	Fz	Frequency (Hz)	Fx	Fy ug/lb–f	Fz
0.0089	2.08	1.32	2.51	0.282	28.68	16.78	41.07	11.22	2132.1	619.3	576.0
0.0089	2.08	1.32	2.51	0.355	28.68	16.78	41.07	11.22	2016.7	1280.7	604.4
0.0112	2.08	1.32	2.51	0.355	154.08	128.84	98.11	14.13	2016.7	1280.7	604.4
0.0112	2.09	1.32	2.51	0.447	154.08	128.84	98.11	14.13	2016.7	1280.7	1024.6
0.0141	2.09	1.32	2.51	0.447	333.91	165.19	151.94	17.78	2016.7	1280.7	1024.6
0.0141	2.10	1.32	2.51	0.562	333.91	165.19	151.94	17.78	2016.7	1280.7	1024.6
0.0178	2.10	1.32	2.51	0.562	333.91	230.47	360.66	22.39	2016.7	1280.7	1024.6
0.0178	2.12	1.31	2.51	0.708	333.91	230.47	360.66	22.39	1768.8	672.9	1607.9
0.0224	2.12	1.31	2.51	0.708	218.64	230.47	360.66	28.18	1768.8	672.9	1607.9
0.0224	2.16	1.31	2.51	0.891	218.64	230.47	360.66	28.18	3398.6	3157.2	2751.8
0.0282	2.16	1.31	2.51	0.891	241.97	230.47	360.66	35.48	3398.6	3157.2	2751.8
0.0282	2.23	1.31	2.51	1.122	241.97	230.47	360.66	35.48	3398.6	3157.2	2751.8
0.0355	2.23	1.31	2.51	1.122	241.97	162.90	267.86	44.67	3398.6	3157.2	2751.8
0.0355	2.38	1.30	2.50	1.413	241.97	162.90	267.86	44.67	3398.6	3157.2	2751.8
0.0447	2.38	1.30	2.50	1.413	163.18	84.42	171.20	56.23	3398.6	3157.2	2751.8
0.0447	2.87	1.29	3.35	1.778	163.18	84.42	171.20	56.23	1979.1	2043.2	877.8
0.0562	2.87	1.29	3.35	1.778	580.05	188.32	161.73	70.79	1979.1	2043.2	877.8
0.0562	26.62	12.86	10.14	2.239	580.05	188.32	161.73	70.79	1879.8	2131.6	846.1
0.0708	26.62	12.86	10.14	2.239	580.05	188.32	161.73	89.13	1879.8	2131.6	846.1
0.0708	30.50	12.86	10.14	2.818	580.05	188.32	161.73	89.13	1820.9	2248.0	831.1
0.0891	30.50	12.86	10.14	2.818	580.05	106.17	198.90	112.20	1820.9	2248.0	831.1
0.0891	30.50	12.86	4.28	3.548	580.05	106.17	198.90	112.20	1783.7	2390.9	825.7
0.1122	30.50	12.86	4.28	3.548	414.72	106.17	198.90	141.30	1783.7	2390.9	825.7
0.1122	36.74	9.60	23.18	4.467	414.72	106.17	198.90	141.30	2130.7	3117.1	1001.9
0.1413	36.74	9.60	23.18	4.467	414.72	106.17	198.90	177.80	2130.7	3117.1	1001.9
0.1413	36.74	46.95	23.18	5.623	414.72	106.17	198.90	177.80	2163.3	3413.2	1031.4
0.1778	36.74	46.95	23.18	5.623	2132.10	79.33	220.33	223.90	2163.3	3413.2	1031.4
0.1778	36.74	46.95	26.83	7.079	2132.10	79.33	220.33	223.90	2130.0	3611.1	1029.4
0.2239	36.74	46.95	26.83	7.079	2132.10	206.24	323.79	281.80	2130.0	3611.1	1029.4
0.2239	27.49	46.95	41.07	8.913	2132.10	206.24	323.79	281.80	2202.9	4005.5	1079.1
0.2818	27.49	46.95	41.07	8.913	2132.10	619.25	576.03	354.80	2202.9	4005.5	1079.1

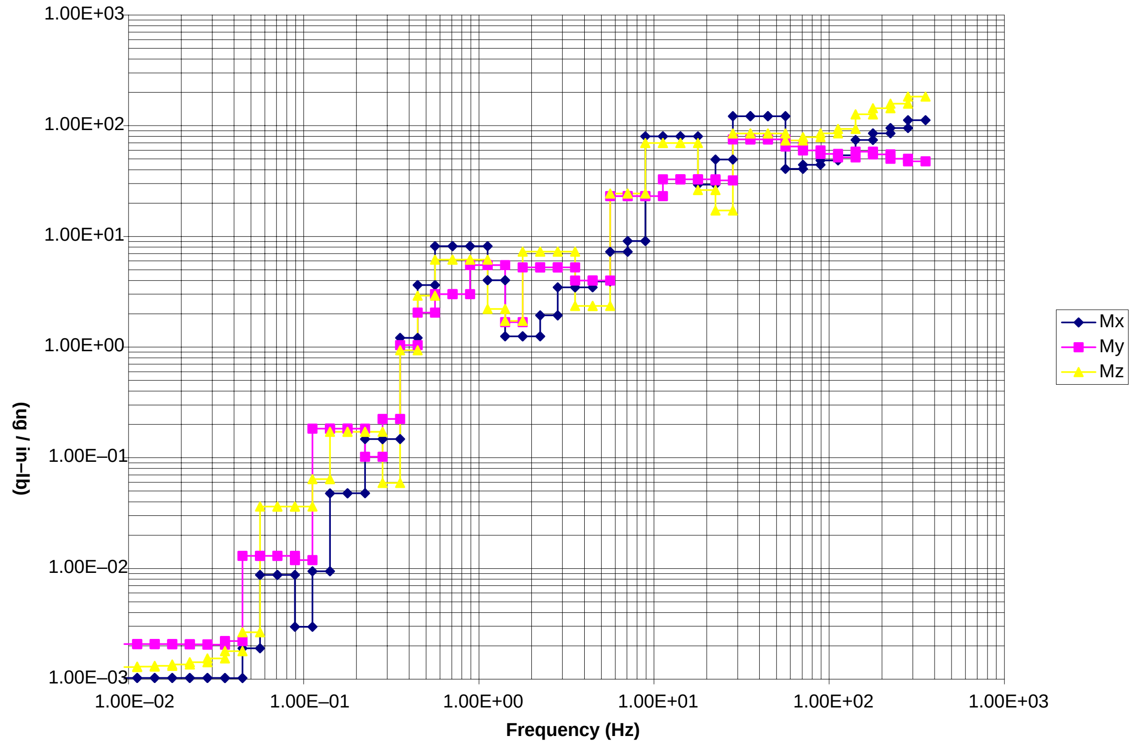


FIGURE 3.1.3.2.6.2.1–3 ONE–THIRD OCTAVE MOMENT NARROW–BAND TRANSFER FUNCTIONS FOR ATTACHED PAYLOADS

TABLE 3.1.3.2.6.2.1–3 ONE–THIRD OCTAVE MOMENT NARROW–BAND TRANSFER FUNCTIONS FOR ATTACHED PAYLOADS

Freq. (Hz)	Mx	My ug/in–lb	Mz	Freq. (Hz)	Mx	My ug/in–lb	Mz	Freq. (Hz)	Mx	My ug/in–lb	Mz
0.0089	0.0010	0.0021	0.0013	0.3548	0.147	0.22	0.06	11.22	80.33	32.74	69.88
0.0112	0.0010	0.0021	0.0013	0.3548	1.214	1.04	0.94	14.13	80.33	32.74	69.88
0.0112	0.0010	0.0021	0.0013	0.4467	1.214	1.04	0.94	14.13	80.33	32.74	69.88
0.0141	0.0010	0.0021	0.0013	0.4467	3.629	2.05	2.92	17.78	80.33	32.74	69.88
0.0141	0.0010	0.0021	0.0013	0.5623	3.629	2.05	2.92	17.78	29.35	32.74	26.26
0.0178	0.0010	0.0021	0.0013	0.5623	8.149	3.01	6.17	22.39	29.35	32.74	26.26
0.0178	0.0010	0.0021	0.0014	0.7079	8.149	3.01	6.17	22.39	49.49	32.05	17.15
0.0224	0.0010	0.0021	0.0014	0.7079	8.149	3.01	6.17	28.18	49.49	32.05	17.15
0.0224	0.0010	0.0021	0.0014	0.8913	8.149	3.01	6.17	28.18	122.06	75.33	85.09
0.0282	0.0010	0.0021	0.0014	0.8913	8.149	5.51	6.17	35.48	122.06	75.33	85.09
0.0282	0.0010	0.0021	0.0015	1.1220	8.149	5.51	6.17	35.48	122.06	75.33	85.09
0.0355	0.0010	0.0021	0.0015	1.1220	4.022	5.51	2.21	44.67	122.06	75.33	85.09
0.0355	0.0010	0.0022	0.0018	1.4130	4.022	5.51	2.21	44.67	122.06	75.33	85.09
0.0447	0.0010	0.0022	0.0018	1.4130	1.248	1.68	1.73	56.23	122.06	75.33	85.09
0.0447	0.0019	0.0130	0.0026	1.7780	1.248	1.68	1.73	56.23	40.78	65.08	73.74
0.0562	0.0019	0.0130	0.0026	1.7780	1.248	5.25	7.29	70.79	40.78	65.08	73.74
0.0562	0.0087	0.0130	0.0363	2.2390	1.248	5.25	7.29	70.79	44.29	59.74	78.93
0.0708	0.0087	0.0130	0.0363	2.2390	1.931	5.25	7.29	89.13	44.29	59.74	78.93
0.0708	0.0087	0.0130	0.0363	2.8180	1.931	5.25	7.29	89.13	48.64	55.59	85.48
0.0891	0.0087	0.0130	0.0363	2.8180	3.472	5.25	7.29	112.20	48.64	55.59	85.48
0.0891	0.0030	0.0119	0.0363	3.5480	3.47	5.25	7.29	112.20	54.03	51.89	93.62
0.1122	0.0030	0.0119	0.0363	3.5480	3.47	3.99	2.35	141.30	54.03	51.89	93.62
0.1122	0.0094	0.1832	0.0640	4.4670	3.47	3.99	2.35	141.30	74.17	58.17	126.52
0.1413	0.0094	0.1832	0.0640	4.4670	3.91	3.99	2.35	177.80	74.17	58.17	126.52
0.1413	0.0477	0.1832	0.1716	5.6230	3.91	3.99	2.35	177.80	85.37	55.23	143.62
0.1778	0.048	0.18	0.17	5.6230	7.27	23.15	24.38	223.90	85.37	55.23	143.62
0.1778	0.048	0.18	0.17	7.0790	7.27	23.15	24.38	223.90	95.25	50.40	158.10
0.2239	0.048	0.18	0.17	7.0790	9.05	23.15	24.38	281.80	95.25	50.40	158.10
0.2239	0.147	0.10	0.17	8.9130	9.05	23.15	24.38	281.80	112.09	47.69	183.54
0.2818	0.147	0.10	0.17	8.9130	80.33	23.15	69.88	354.80	112.09	47.69	183.54
0.2818	0.147	0.22	0.06	11.2200	80.33	23.15	69.88				

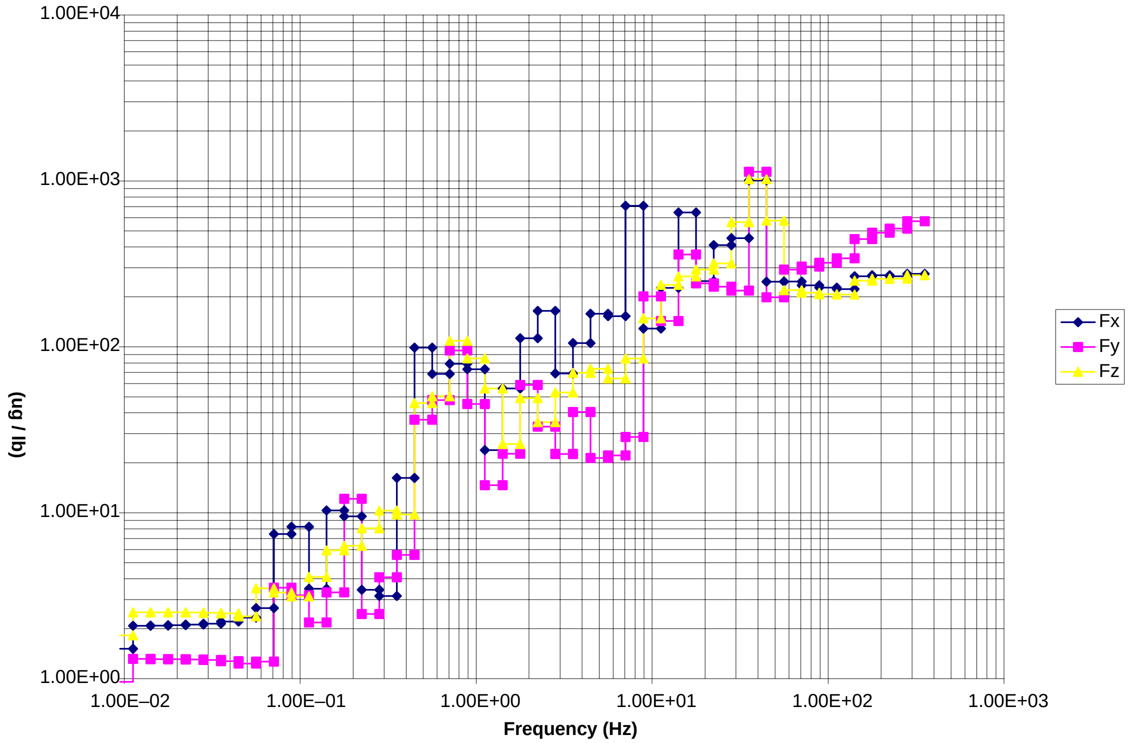


FIGURE 3.1.3.2.6.2.1–4 ONE–THIRD OCTAVE WIDE–BAND FORCE TRANSFER FUNCTIONS FOR ATTACHED PAYLOADS

TABLE 3.1.3.2.6.2.1–4 ONE–THIRD OCTAVE WIDE–BAND FORCE TRANSFER FUNCTIONS FOR ATTACHED PAYLOADS

Frequency (Hz)	Fx	Fy ug/lb–f	Fz	Frequency (Hz)	Fx	Fy ug/lb–f	Fz	Frequency (Hz)	Fx	Fy ug/lb–f	Fz
0.009	1.51	0.96	1.83	0.35	3.2	4.1	10.3	11.2	226.3	143.0	236.5
0.011	1.51	0.96	1.83	0.35	16.2	5.6	9.8	14.1	226.3	143.0	236.5
0.011	2.08	1.32	2.51	0.45	16.2	5.6	9.8	14.1	645.5	360.8	265.7
0.014	2.08	1.32	2.51	0.45	98.8	36.4	45.8	17.8	645.5	360.8	265.7
0.014	2.09	1.31	2.51	0.56	98.8	36.4	45.8	17.8	249.2	241.2	292.5
0.018	2.09	1.31	2.51	0.56	68.7	47.7	50.4	22.4	249.2	241.2	292.5
0.018	2.10	1.31	2.51	0.71	68.7	47.7	50.4	22.4	409.8	230.2	318.4
0.022	2.10	1.31	2.51	0.71	79.0	95.1	108.6	28.2	409.8	230.2	318.4
0.022	2.12	1.31	2.51	0.89	79.0	95.1	108.6	28.2	451.6	218.7	564.9
0.028	2.12	1.31	2.51	0.89	73.4	45.3	85.2	35.5	451.6	218.7	564.9
0.028	2.15	1.30	2.50	1.12	73.4	45.3	85.2	35.5	1008.4	1137.1	1023.8
0.035	2.15	1.30	2.50	1.12	23.8	14.6	56.2	44.7	1008.4	1137.1	1023.8
0.035	2.21	1.28	2.47	1.41	23.8	14.6	56.2	44.7	247.3	199.0	576.5
0.045	2.21	1.28	2.47	1.41	56.2	22.7	26.0	56.23	247.3	199.0	576.5
0.045	2.33	1.23	2.38	1.78	56.2	22.7	26.0	56.23	247.4	291.9	219.5
0.056	2.33	1.23	2.38	1.78	112.7	58.9	49.1	70.79	247.4	291.9	219.5
0.056	2.66	1.27	3.50	2.24	112.7	58.9	49.1	70.79	235.0	304.5	211.5
0.071	2.66	1.27	3.50	2.24	164.6	33.0	35.2	89.13	235.0	304.5	211.5
0.071	7.43	3.54	3.31	2.82	164.6	33.0	35.2	89.13	227.6	321.1	207.8
0.089	7.43	3.54	3.31	2.82	69.1	22.6	53.1	112.20	227.6	321.1	207.8
0.089	8.24	3.18	3.14	3.55	69.1	22.6	53.1	112.20	223.0	341.6	206.4
0.112	8.24	3.18	3.14	3.5	105.5	40.4	69.6	141.30	223.0	341.6	206.4
0.112	3.49	2.18	4.10	4.5	105.5	40.4	69.6	141.30	266.3	445.3	250.5
0.141	3.49	2.18	4.10	4.5	158.4	21.4	73.6	177.80	266.3	445.3	250.5
0.141	10.31	3.31	5.94	5.6	158.4	21.4	73.6	177.80	270.4	487.6	257.8
0.18	10.31	3.31	5.94	5.6	153.1	22.2	64.4	223.90	270.4	487.6	257.8
0.18	9.5	12.1	6.3	7.1	153.1	22.2	64.4	223.90	266.3	515.9	257.3
0.22	9.5	12.1	6.3	7.1	707.0	28.6	85.0	281.80	266.3	515.9	257.3
0.22	3.4	2.5	8.1	8.9	707.0	28.6	85.0	281.80	275.4	572.2	269.8
0.28	3.4	2.5	8.1	8.9	129.0	201.6	148.6	354.80	275.4	572.2	269.8
0.28	3.2	4.1	10.3	11.2	129.0	201.6	148.6				

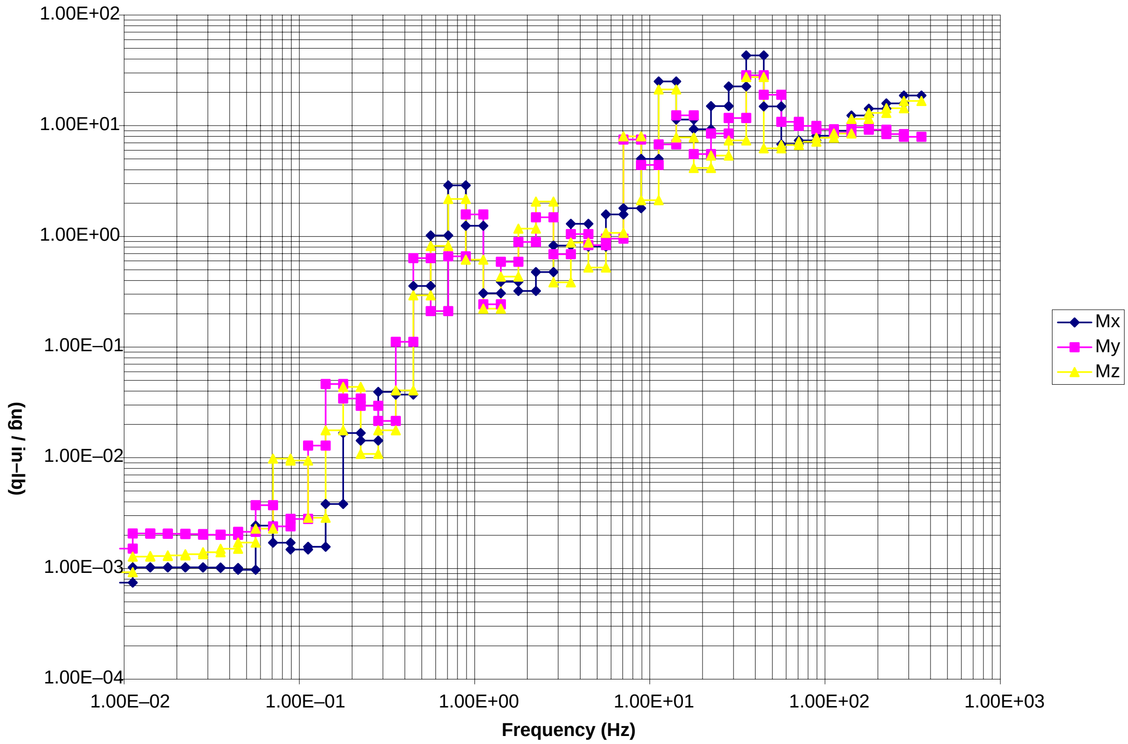


FIGURE 3.1.3.2.6.2.1–5 ONE–THIRD OCTAVE MOMENT WIDE–BAND TRANSFER FUNCTIONS FOR ATTACHED PAYLOADS

TABLE 3.1.3.2.6.2.1–5 ONE–THIRD OCTAVE INTERFACE WIDE–BAND MOMENT TRANSFER FUNCTION VALUES FOR ATTACHED PAYLOADS

Freq. (Hz)	Mx	My ug/in–lb	Mz	Freq. (Hz)	Mx	My ug/in–lb	Mz	Freq. (Hz)	Mx	My ug/in–lb	Mz
0.009	0.0007	0.0015	0.0009	0.35	0.039	0.021	0.018	11.2	25.16	6.77	21.23
0.011	0.0007	0.0015	0.0009	0.35	0.037	0.111	0.041	14.1	25.16	6.77	21.23
0.011	0.0010	0.0021	0.0013	0.45	0.037	0.111	0.041	14.1	11.36	12.40	7.84
0.014	0.0010	0.0021	0.0013	0.45	0.357	0.637	0.293	17.8	11.36	12.40	7.84
0.014	0.0010	0.0021	0.0013	0.56	0.357	0.637	0.293	17.8	9.27	5.53	4.15
0.018	0.0010	0.0021	0.0013	0.56	1.018	0.212	0.818	22.4	9.27	5.53	4.15
0.018	0.0010	0.0021	0.0013	0.71	1.018	0.212	0.818	22.4	15.03	8.51	5.37
0.022	0.0010	0.0021	0.0013	0.71	2.893	0.661	2.184	28.2	15.03	8.51	5.37
0.022	0.0010	0.0020	0.0013	0.89	2.893	0.661	2.184	28.2	22.57	11.75	7.38
0.028	0.0010	0.0020	0.0013	0.89	1.246	1.578	0.617	35.5	22.57	11.75	7.38
0.028	0.0010	0.0020	0.0014	1.12	1.246	1.578	0.617	35.5	43.18	28.61	27.54
0.035	0.0010	0.0020	0.0014	1.12	0.307	0.244	0.222	44.7	43.18	28.61	27.54
0.035	0.0010	0.0020	0.0015	1.41	0.307	0.244	0.222	44.7	14.89	19.03	6.26
0.045	0.0010	0.0020	0.0015	1.41	0.390	0.590	0.433	56.2	14.89	19.03	6.26
0.045	0.0010	0.0021	0.0017	1.78	0.390	0.590	0.433	56.2	6.80	10.85	6.70
0.056	0.0010	0.0021	0.0017	1.78	0.322	0.893	1.178	70.8	6.80	10.85	6.70
0.056	0.0024	0.0037	0.0023	2.24	0.322	0.893	1.178	70.8	7.38	9.96	7.18
0.071	0.0024	0.0037	0.0023	2.24	0.476	1.486	2.062	89.1	7.38	9.96	7.18
0.071	0.0017	0.0024	0.0098	2.82	0.476	1.486	2.062	89.1	8.11	9.27	7.77
0.089	0.0017	0.0024	0.0098	2.82	0.825	0.691	0.385	112.2	8.11	9.27	7.77
0.089	0.0015	0.0028	0.0095	3.55	0.825	0.691	0.385	112.2	9.01	8.65	8.51
0.112	0.0015	0.0028	0.0095	3.55	1.300	1.049	0.882	141.3	9.01	8.65	8.51
0.112	0.0016	0.0129	0.0029	4.47	1.300	1.049	0.882	141.3	12.36	9.69	11.50
0.141	0.0016	0.0129	0.0029	4.47	0.808	0.833	0.523	177.8	12.36	9.69	11.50
0.141	0.0038	0.0464	0.0177	5.62	0.808	0.833	0.523	177.8	14.23	9.21	13.06
0.178	0.0038	0.0464	0.0177	5.62	1.577	0.954	1.079	223.9	14.23	9.21	13.06
0.178	0.0167	0.0342	0.0437	7.08	1.577	0.954	1.079	223.9	15.88	8.40	14.37
0.224	0.0167	0.0342	0.0437	7.08	1.794	7.493	8.025	281.8	15.88	8.40	14.37
0.224	0.0143	0.0295	0.0108	8.91	1.794	7.493	8.025	281.8	18.68	7.95	16.69
0.282	0.0143	0.0295	0.0108	8.91	5.004	4.422	2.127	354.8	18.68	7.95	16.69
0.282	0.0394	0.0215	0.0177	11.22	5.004	4.422	2.127				

3.1.3.2.6.2.2 TRANSIENT REQUIREMENTS

A. Attached Payloads shall limit force applied to the ISS over any ten second period to an impulse of no greater than 10 lb–s (44.5 N–s).

B. Attached Payloads shall limit their peak force applied to the ISS to less than 1000 lb (4448 N) for any duration.

Note: Meeting the transient requirements of both A and B does not obviate the need to also meet the 100 second vibration requirement of 3.1.3.2.6.2.1 for vibration included in and following the transient disturbance.

3.1.3.2.6.3 ANGULAR MOMENTUM LIMITS

This requirement applies only to payload disturbance forces and moments which generate pure internal angular momentum impulse greater than 100 ft–lb–sec (135 N–m–sec) or a maximum impulse greater than 1.1 lb–s (4.9 N–s) over any continuous period of 9 minutes.

The following general requirements apply to the determination of applicability as stated above and to the evaluation of the ability of payloads to meet the limits of 3.1.3.2.6.3.1 and 3.1.3.2.6.3.2:

A. It is not necessary to consider transient or cyclic angular moments that exceed limits over shorter intervals than the specified continuous duration if the cumulative angular momentum impulse limit is not exceeded by the end of the specified continuous duration.

B. The beginning and end times of continuous periods may be arranged in any order, as long as all periods of operation are covered in one or more continuous period. This permits start–ups followed by stopping actions within any 9 minute window to be considered as cancelled angular impulse.

C. Shorter duration angular momentum impulse sources are covered by the microgravity transient and vibratory force limits, assuming standard ISPR attachment point separation distances.

D. If the disturbance source produces translational forces, the disturbance torque due to the disturbance force will be calculated using the moment arm from the point of application of the force to the ISS Assembly Complete configuration center of mass. The location of the Assembly Complete configuration center of mass is specified in JSC–26557, ISS On–Orbit Assembly, Modeling and Mass Properties Databook.

E. If the disturbance source produces forces and moments, the disturbance moment due to the disturbance force will be added to the induced pure moments.

F. The locations of pure moments do not need to be reported.

3.1.3.2.6.3.1 LIMIT DISTURBANCE INDUCED ISS ATTITUDE RATE

When the on–orbit Space Station is in the microgravity mode, any nontransitory disturbance induced on the on–orbit Space Station by an individual disturbance source of a payload shall have an angular momentum impulse of less than the per axis values shown in Table 3.1.3.2.6.3.1–1 during any continuous nine minute period. Over no interval of time of 10 seconds or less shall a payload angular momentum impulse exceed 250 ft–lb–s (340 N–m–s), and over no interval of time of 2 minutes or less shall a payload angular momentum impulse exceed 2900 ft–lb–s (3930 N–m–s). Angular momentum impulse due to gyroscopic moments (the cross–product of ISS orbital rate with payload angular momentum) may be excluded from these limits if the payload gyroscopic moment does not exceed 6 ft–lb (8.14 N–m).

TABLE 3.1.3.2.6.3.1–1 MAXMUM ANGULAR MOMENTUM IMPULSE

Axis	Hx	Hy	Hz
ft–lb–sec	930	1277	2876
N–m–sec	1261	1732	3900

Note: Where Hx, Hy and Hz are the x, y, and z components of the disturbance angular momentum relative to the coordinate system specified in SSP 30219, Figure 4.0–3.

3.1.3.2.6.3.2 LIMIT DISTURBANCE INDUCED CMG MOMENTUM USAGE

When the on–orbit Space Station is in the microgravity mode, any disturbance induced on the on–orbit Space Station by an individual disturbance source of a payload shall have an angular momentum impulse that produces an estimated Control Moment Gyroscope (CMG) momentum magnitude less than 10,000 ft–lb–sec (13,558 N–m–sec) during any continuous 110 minute period when evaluated per the expression in Table 3.1.3.2.6.3.2–1. Angular momentum impulse due to gyroscopic moments (the cross–product of ISS orbital rate with payload angular momentum) may be excluded from these limits if the payload gyroscopic moment does not exceed 6 ft–lb (8.14 N–m).

TABLE 3.1.3.2.6.3.2–1 CMG MOMENTUM USAGE CALCULATION

Estimated CMG Momentum Usage	
ft–lb–sec	SQRT((1.25*Hx+1069)**2 + (1.25*Hy+6885)**2 + (1.25*Hz+779)**2) < 10,000
N–m–sec	SQRT((1.25*Hx+1449)**2 + (1.25*Hy+9334)**2 + (1.25*Hz+1056)**2) < 13,558

Notes:

(1) Where Hx, Hy, and Hz are the x, y, and z components of the disturbance angular momentum impulse using the coordinate system specified in SSP 30219, Figure 4.0–3.

(2) Where 1069, 6885, and 779 ft–lb–sec (and 1449, 9334, and 1056 N–m–sec) are the x, y, and z components, respectively, of the CMG angular momentum allocation for environmental disturbances.

3.1.3.2.7 CONTACT SURFACES

The Attached Payload Capture Bar, Guide Pins, and associated Passive Half platform structure subject to contact shall be coated with a dry film lubricant and provide a .25” minimum edge radius as depicted in SSP 57004, Figure 3.1.2.2–1.

3.1.4 INTERFACE WITH SPACE STATION EXTRAVEHICULAR ROBOTICS

3.1.4.1 INTERFACE WITH NSTS REMOTE MANIPULATOR SYSTEM AND SPACE STATION REMOTE MANIPULATOR SYSTEM

Attached Payload interfaces with the SRMS and SSRMS for on–orbit activities shall be designed in accordance with paragraph 3.7.1 and 3.7.3.

3.1.4.1.1 GRAPPLE FIXTURE LOCATIONS

The Attached Payload shall locate grapple fixture(s) in accordance with paragraphs 3.7.1 and 3.7.3 and locate it (them) so as to not exceed the structural and mechanical capability of the PAS/UCCAS sites.

3.1.4.1.2 GRAPPLE FIXTURE STRUCTURAL SUPPORT

Attached Payloads shall provide the secondary structural support for grapple fixtures to facilitate SRMS and SSRMS robotic operations in accordance with paragraphs 3.7.1 and 3.7.3.

3.1.4.2 INTERFACE WITH SPECIAL PURPOSE DEXTEROUS MANIPULATOR

Attached Payload interfaces with the Special Purpose Dexterous Manipulator (SPDM) for on–orbit activities (loading/unloading of payload items) shall be in accordance with paragraph 3.7.4.

3.1.4.2.1 SPECIAL PURPOSE DEXTEROUS MANIPULATOR FIXTURE LOCATIONS

A. The Attached Payload shall include all stabilization aids (i.e., H–fixture) necessary for all dexterous robotics operations to be conducted on the Attached Payload in accordance with SSP 30550, paragraph 3.4.10. There are no stabilization aids on the ISS truss to support Attached Payload related SPDM operations.

B. SPDM fixtures shall be placed such that operational induced loads do not exceed the structural and mechanical capability of the PAS/UCCAS sites.

3.1.4.2.2 SPECIAL PURPOSE DEXTEROUS MANIPULATOR FIXTURE STRUCTURAL SUPPORT

Every SPDM designated worksite shall provide the secondary structural support for a H–fixture interface to facilitate robotic operations in accordance with paragraph 3.7.4.

3.2 ELECTRICAL INTERFACE REQUIREMENTS

3.2.1 ELECTRICAL INTERFACE WITH MOBILE SERVICING SYSTEM MCAS

The Attached Payload requiring an electrical interface will be designed to interface with the MCAS active UMA to receive electrical power from the ISS during MBS operations in accordance with SSP 42004, paragraph B3.2.2.5. Electrical power characteristics of the MCAS are similar to electrical power characteristics of the PAS/UCCAS sites defined in paragraph 3.2.2 except for the MCAS load impedance requirements defined in paragraphs 3.2.2.2.7 and the Remote Power Controller Overload limit defined in Figure 3.2.5–1 of SSP 57004.

3.2.2 ELECTRICAL POWER INTERFACE WITH THE INTEGRATED TRUSS SEGMENT S3 PAYLOAD ATTACH SYSTEM AND P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

The Attached Payload requiring electrical power services from the ISS will be through the active UMA on the PAS or UCCAS.

3.2.2.1 ELECTRICAL POWER CHARACTERISTICS

Electrical power characteristics are specified in this section for the Attached Payload Port and Starboard Interface, Interface C, as depicted in Figure 3.2.2.1–1. Attached Payloads interfaced to the S3/P3 must be compatible with the prescribed characteristics of the secondary Electrical Power System (EPS). For purposes of this specification, compatibility is defined as operating without producing an unsafe condition or one that could result in damage to ISS equipment or payload hardware.

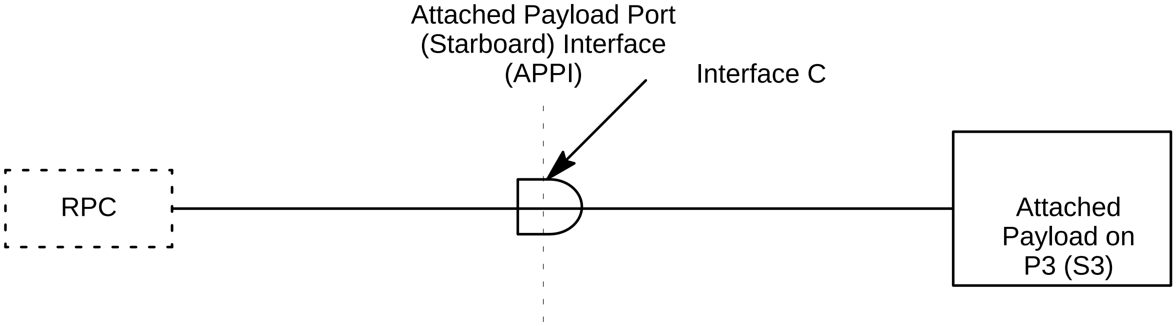


FIGURE 3.2.2.1–1 ELECTRICAL POWER SYSTEM INTERFACE LOCATIONS

3.2.2.1.1 STEADY-STATE VOLTAGE CHARACTERISTICS

The Attached Payload connected to Interface C shall operate and be compatible with the steady-state voltage limits of 112.5 to 126 volts – direct current (Vdc).

3.2.2.1.2 RIPPLE VOLTAGE CHARACTERISTICS

3.2.2.1.2.1 RIPPLE VOLTAGE AND NOISE

The Attached Payload connected to Interface C shall operate and be compatible with the EPS time domain ripple voltage and noise level of 2.5 volts root–mean–square (Vrms) maximum from 30 Hz to 10 kHz.

3.2.2.1.2.2 RIPPLE VOLTAGE SPECTRUM

The Attached Payload connected to Interface C shall operate and be compatible with the EPS ripple voltage spectrum as shown in Figure 3.2.2.1.2.2–1.

Note: This limit is 6 decibel (dB) below the Electromagnetic Compatibility (EMC) CS-01, 02 requirement in SSP 30237, Space Station Requirements for Electromagnetic Emission and Susceptibility Requirements, up to 30 MHz.

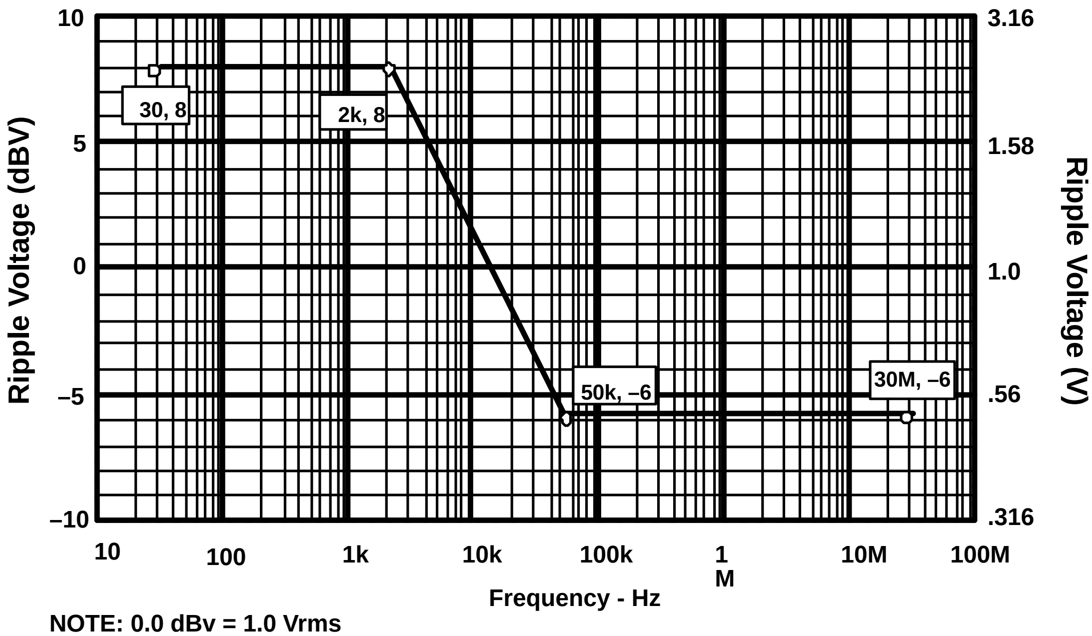


FIGURE 3.2.2.1.2.2–1 MAXIMUM INTERFACES B AND C RIPPLE VOLTAGE SPECTRUM

3.2.2.1.3 TRANSIENT VOLTAGES

3.2.2.1.3.1 NORMAL TRANSIENT VOLTAGES

The Attached Payload connected to Interface C shall operate and be compatible with the limits of magnitude and duration of the voltage transients as shown in Figure 3.2.2.1.3.1–1. The envelope shown in this figure applies to the transient responses exclusive of any periodic ripple or noise components that may be present.

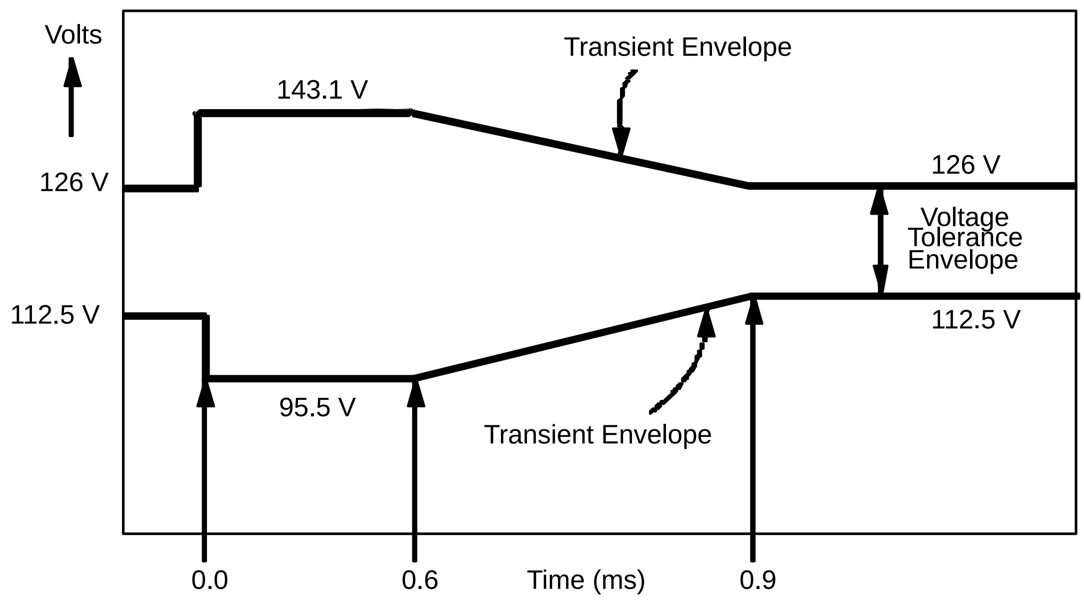
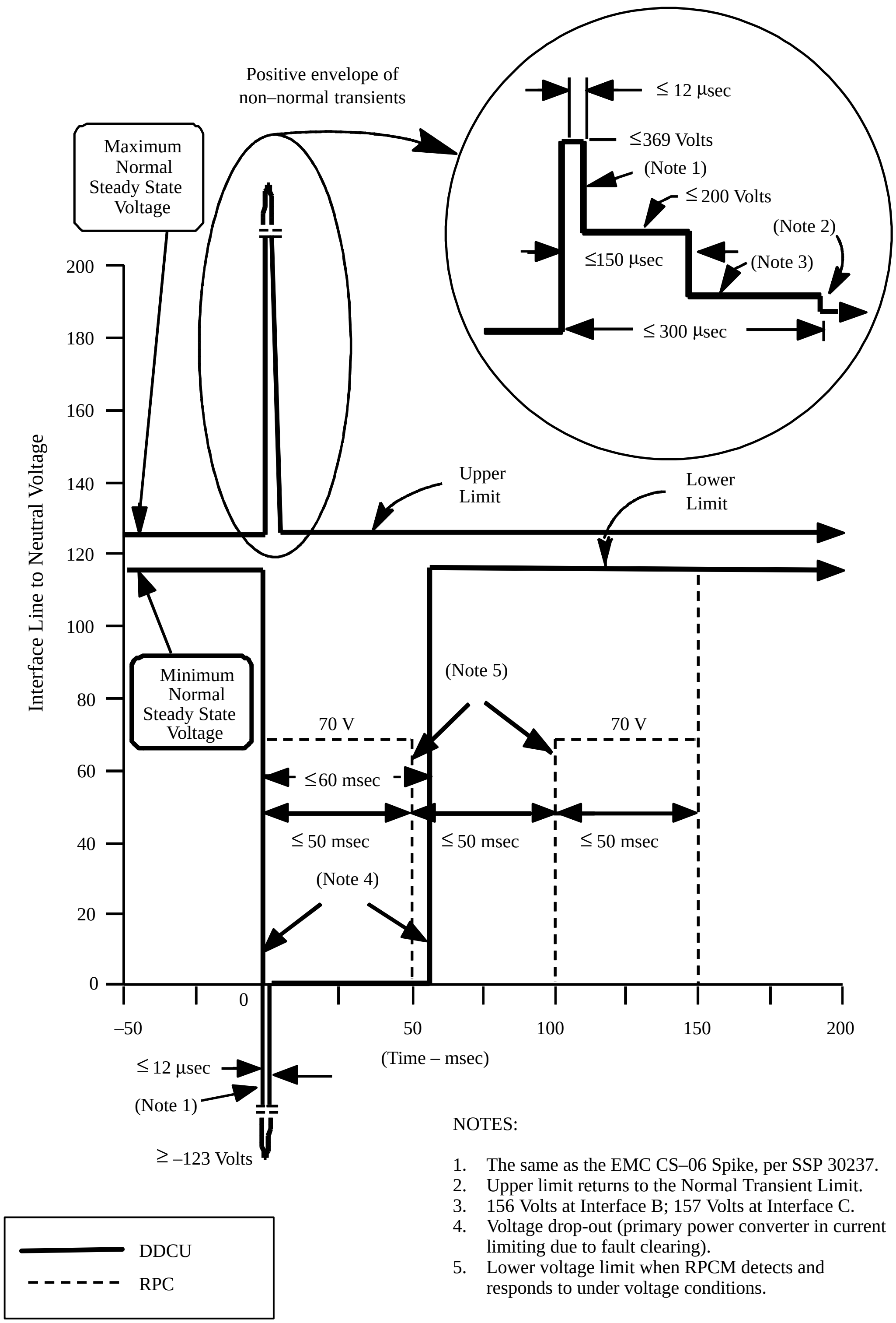


FIGURE 3.2.2.1.3.1–1 INTERFACE C NORMAL VOLTAGE TRANSIENTS

3.2.2.1.3.2 FAULT CLEARING AND PROTECTION

The Attached Payload connected to Interface C shall be safe and not suffer damage with the transient voltage conditions that are within the limits shown in Figure 3.2.2.1.3.2–1. Loads may be exposed to transient overvoltage conditions during operation of the power system's fault protection components.



NOTES:

1. The same as the EMC CS–06 Spike, per SSP 30237.
2. Upper limit returns to the Normal Transient Limit.
3. 156 Volts at Interface B; 157 Volts at Interface C.
4. Voltage drop-out (primary power converter in current limiting due to fault clearing).
5. Lower voltage limit when RPCM detects and responds to under voltage conditions.

FIGURE 3.2.2.1.3.2–1 FAULT CLEARING AND PROTECTION TRANSIENT LIMITS

3.2.2.1.3.3 INTERFACE C NON-NORMAL VOLTAGE RANGE

The Attached Payload connected to Interface C shall not produce an unsafe condition or one that could result in damage to ISS equipment with the following non-normal voltage characteristics:

A. Maximum overvoltage of + 165 Volts direct current (Vdc) for up to 10 sec.

B. Undervoltage conditions of +102 Vdc for an indefinite period of time.

3.2.2.2 ELECTRICAL POWER INTERFACE

3.2.2.2.1 ATTACHED PAYLOAD CONNECTORS AND PIN ASSIGNMENTS

A. Attached Payloads shall utilize the passive UMA connector P/N NUR1–005 and shall meet the requirements for this connector as defined in SSQ 21637 or equivalent.

B. Attached Payloads shall meet the pin assignments and avionics interface terminations as specified in the unique payload hardware ICD per SSP 57004, paragraph 3.2.1, in order to mate with the active UMA connector.

3.2.2.2.2 POWER BUS ISOLATION

A. Attached Payloads requiring power from two independent ISS power feeds shall provide a minimum of 1-megohm isolation in parallel with not more than 0.03 microfarads of mutual capacitance between the two independent power feeds including the supply and return lines within the Attached Payload at all times such that no single failure shall cause the independent power feeds to be electrically tied. (Mutual capacitance is defined as line-to-line capacitance, exclusive of the EMI input filter.)

B. The Attached Payload shall not use diodes to electrically tie together independent ISS power bus high side or return lines.

Note: ISS provides two feeds, each powered by a single DDCU (6.25 kW), for the Attached Payloads and ULCs at the S3/P3 attach sites. Each site receives power from both feeds with power on each feed limited to 3kW by the S3/P3 circuit protection devices. Each site must use one of the feeds as Main (primary) power, for operational use, and the other as Auxiliary (keep–alive) power, which should be designed to minimize power consumption and must be within the limits defined by Table VIII of SP–M–229 and Table IX of SP–M–235. Attached Payloads and ULCs may use both power feeds simultaneously provided the power bus isolation requirements in this section are met. Specific constraints on the use of Main power and Auxiliary power by Attached Payloads and ULCs will be defined in the payload–unique ICD.

3.2.2.2.3 COMPATIBILITY WITH SOFT START/STOP REMOTE POWER CONTROLLER

The Attached Payload connected to Interface C shall initialize with the soft start/stop performance characteristics when power is applied, sustained, and removed by control of remote power control switches. The soft start/stop function, active only when the Remote Power Controller (RPC) is commanded on or off, is limited to 100 amps/milliseconds (ms), or less, by the RPC output. The response of the soft start/stop function is linear for resistive loads for 1 to 10 ms for S3/P3 feeds.

Note: Soft start/stop characteristics of US standard Remote Power Controller Mechanisms (RPCMs) are shown in Figure 3.2.2.2.3–1.

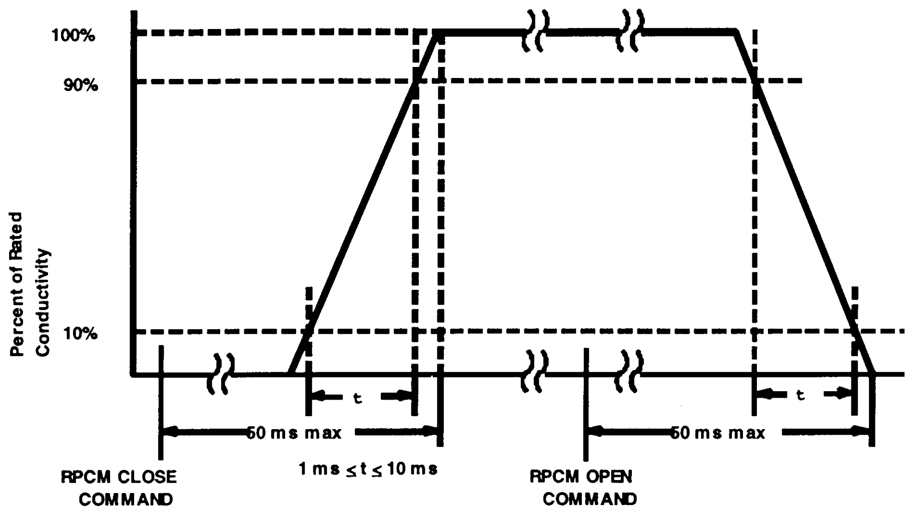


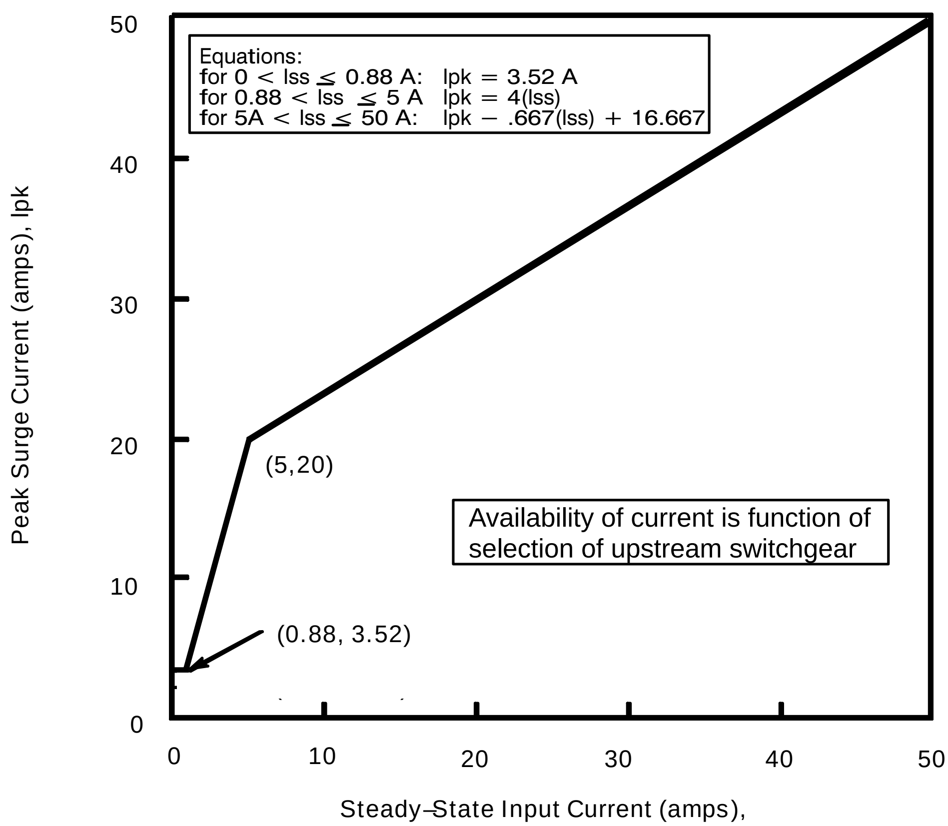
FIGURE 3.2.2.2.3–1 UNITED STATES REMOTE POWER CONTROL MECHANISM SOFT START/STOP CHARACTERISTICS

3.2.2.2.4 SURGE CURRENT

The following requirements apply to the surge current at the power inputs of the Attached Payload connected to Interface C electrical interface when powered from a voltage source with characteristics specified in paragraphs 3.2.2.1 and 3.2.2.2, with the exception that the source impedance is considered to be 0.1 ohm, for all operating modes and changes including power-up and power-down with duration of the surge current not to exceed 10 ms:

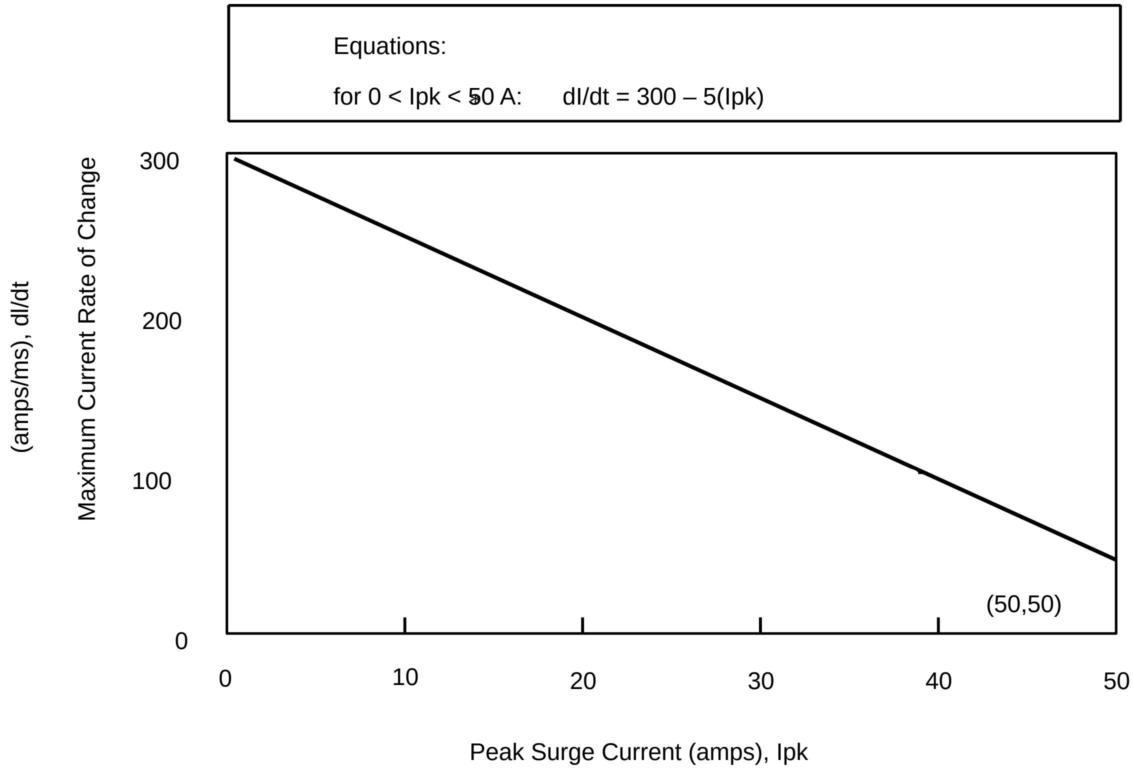
A. The amplitude shall not exceed the values defined in Figure 3.2.2.2.4–1.

B. The rate of current change shall not exceed the values defined in Figure 3.2.2.2.4–2.



Note 1: For transients less than 100 microseconds, refer to SSP 30237

FIGURE 3.2.2.2.4–1 PEAK SURGE CURRENT AMPLITUDE VERSUS STEADY–STATE INPUT CURRENT



Notes:
1) For transients less than 100 microsecs, refer to SSP 30237

FIGURE 3.2.2.2.4–2 MAXIMUM CURRENT RATE OF CHANGE VERSUS PEAK SURGE CURRENT AMPLITUDE

3.2.2.2.5 REVERSE ENERGY/CURRENT

The Attached Payload electrical interface to primary input power and operational keep alive power shall comply with the requirements defined in Table 3.2.2.2.5–1 for the reverse energy/current into the upstream power source. The Attached Payload interface shall meet either the reverse energy or the reverse current requirement for all environmental conditions specified in this document when powered from a voltage source with characteristics specified in paragraphs 3.2.2.1 and 3.2.2.2 with a source impedance of 0.1 ohm.

TABLE 3.2.2.2.5–1 MAXIMUM REVERSE ENERGY/CURRENT FROM DOWNSTREAM LOADS

Attached Payload Interface Power/RPCM type	MAXIMUM REVERSE ENERGY (Joules) and Duration	MAXIMUM REVERSE CURRENT (Amps)		
		Pulse t < 10 μs	Peak 10μs <t < 1 ms	Steady State t > 1ms
3 kW / type II	N/A	400	40	3

ms = microseconds ms = milliseconds s = second

3.2.2.2.6 CIRCUIT PROTECTION DEVICES

3.2.2.2.6.1 INTERNATIONAL SPACE STATION ELECTRICAL POWER SYSTEM CIRCUIT PROTECTION CHARACTERISTICS

A. The Attached Payload connected to the Interface C electrical interface shall operate and be compatible with the characteristics of remote power controllers in Figure 3.2.5–1 as described in paragraph 3.2.5 located in SSP 57004, Attached Payload Hardware Interface Control Document Template.

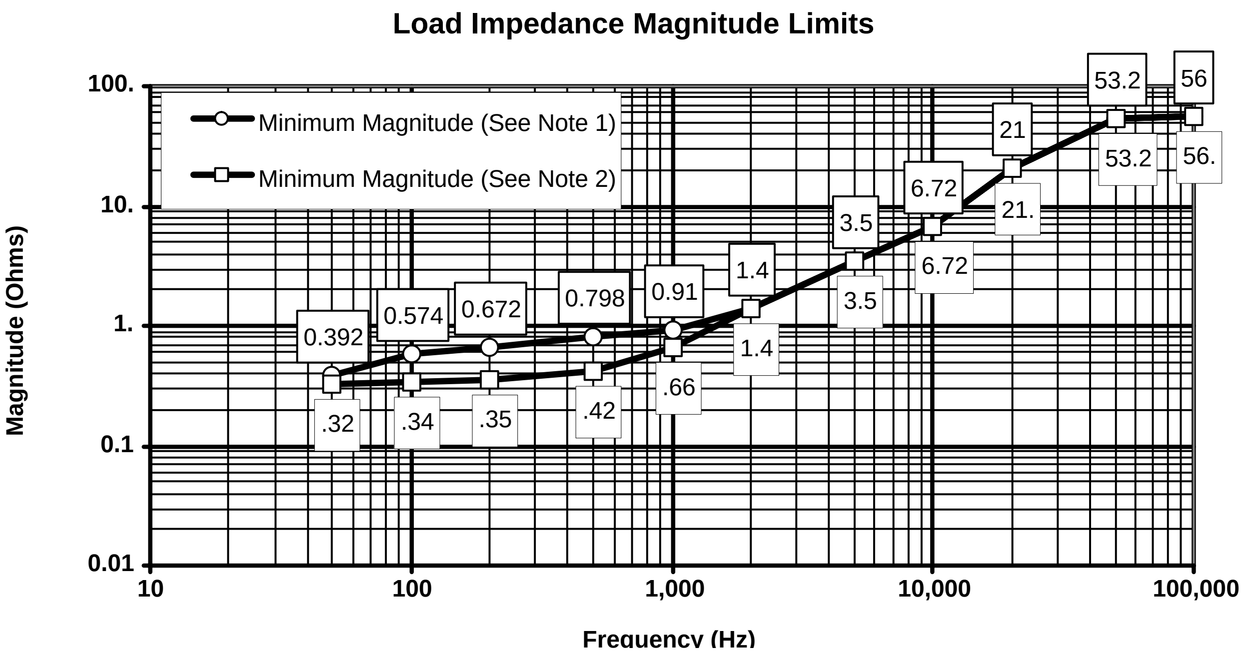
B. Overcurrent protection shall be provided at all points in the system where power is distributed to lower level (wire size not protected by upstream circuit protection device) feeder and branch lines.

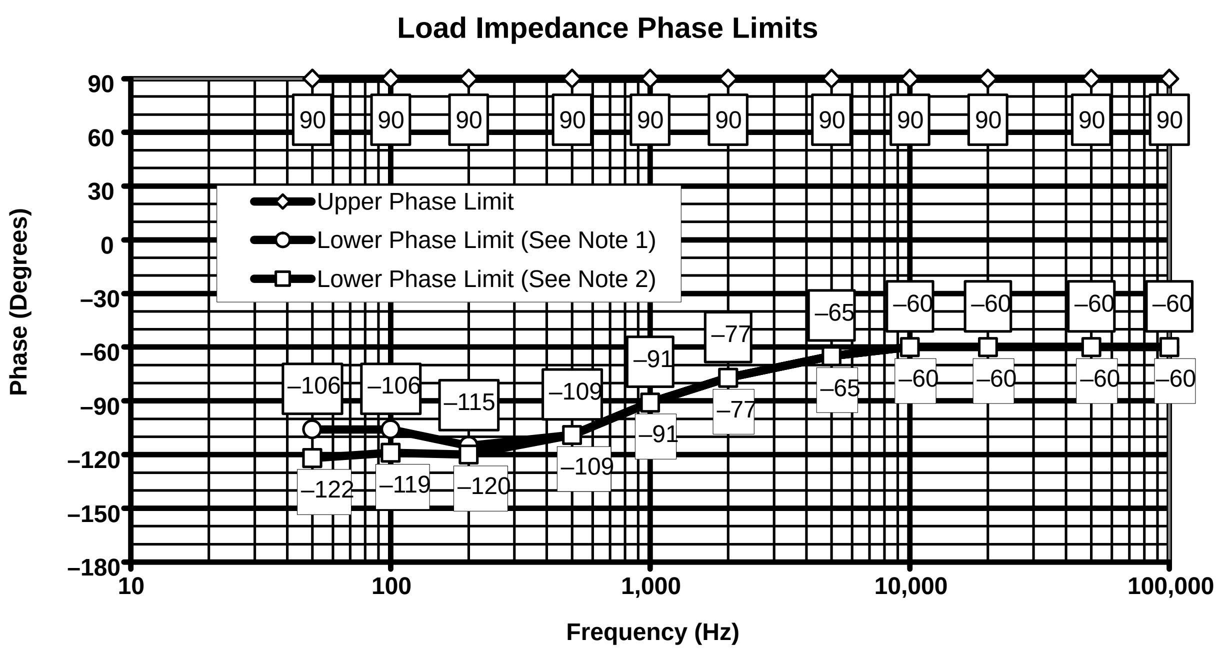
3.2.2.2.6.2 ATTACHED PAYLOAD TRIP RATINGS

The Attached Payload connected to Interface C circuit protection device shall be designed to provide trip coordination, i.e., the downstream circuit protection device disconnects a shorted circuit or an overloaded circuit from the upstream power interface without tripping the upstream circuit protection device. The trip coordination is achieved either by shorter trip time or lower current limitation than the upstream protection devices defined in Paragraph 3.2.2.2.6.1.A.

3.2.2.2.7 INTERFACE C ATTACHED PAYLOAD COMPLEX LOAD IMPEDANCES

The load impedance presented by the Attached Payload to Interface C shall not exceed the bounds defined by Figure 3.2.2.2.7–1 and 3.2.2.2.7–2 for input over the frequency range of 50 Hertz (Hz) to 100 kHz. The magnitude component of the Attached Payload input impedance should not be less than the minimum defined in Figure 3.2.2.2.7–1 and Figure 3.2.2.2.7–2 (for MCAS power interface only). At frequencies where the magnitude component of the Attached Payload input impedance is less than the minimums defined in Figure 3.2.2.2.7–1 and Figure 3.2.2.2.7–2 (for MCAS power interface only), the phase component of the Attached Payload input impedance shall not exceed the bounds defined in 3.2.2.2.7–1 and Figure 3.2.2.2.7–2 (for MCAS power interface only).

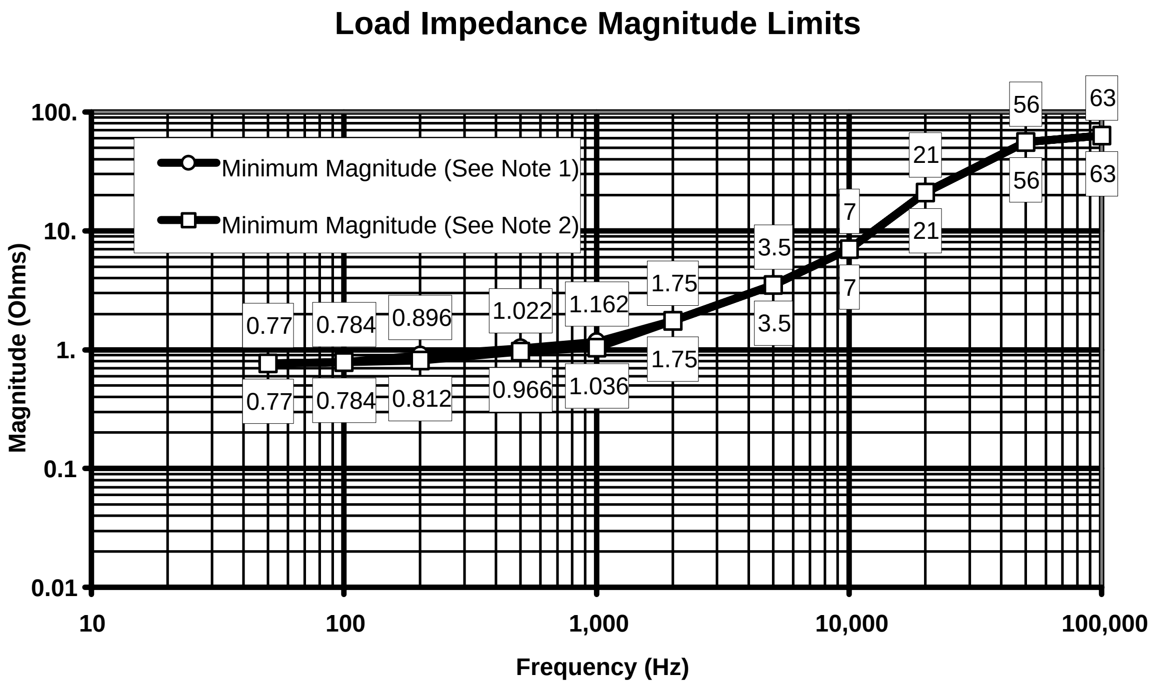


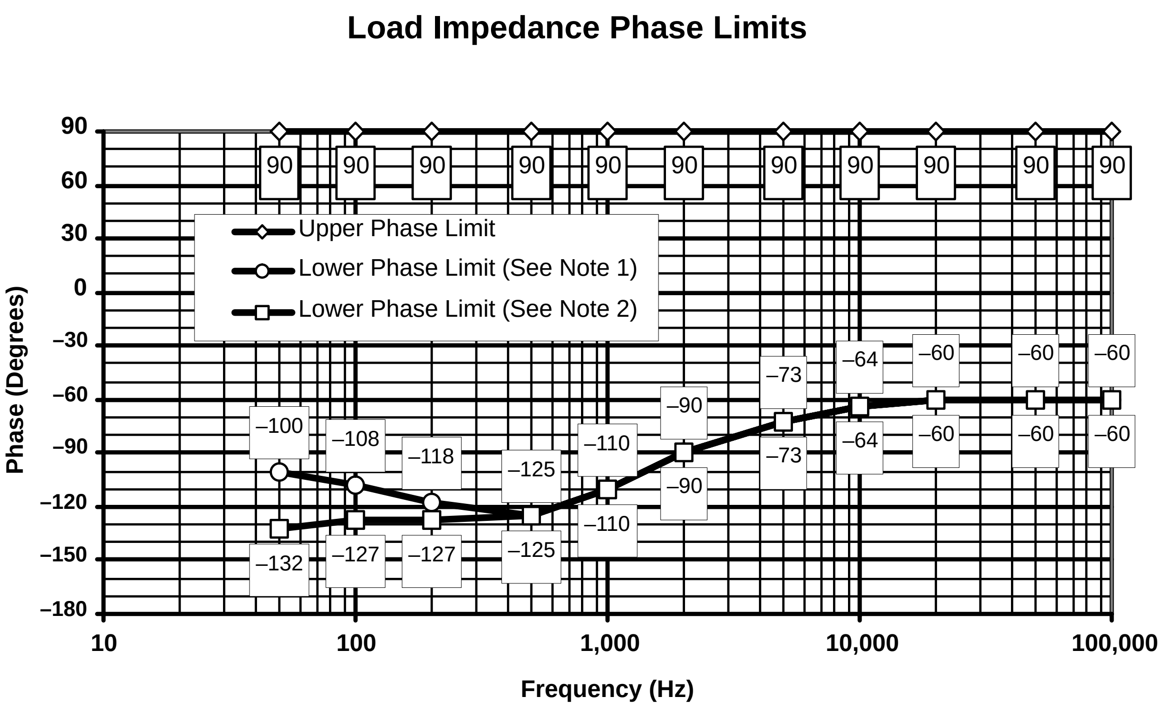


Notes:

1. Limit when steady state EPCE loading is less than 800 watts (see note 3).
2. Limit when steady state EPCE loading is at least 800 watts (see note 3).
3. 800 watts if from two DDCUs operating in parallel, or 400 watts from a single DDCU.

FIGURE 3.2.2.2.7–1 INTERFACE C LOAD IMPEDANCE LIMITS





Notes: 1. Limit when steady state DDCU loading is less than 400 watts.
2. Limit when steady state DDCU loading is at least 400 watts.

FIGURE 3.2.2.2.7–2 MCAS POWER INTERFACE LOAD IMPEDANCE LIMITS

3.2.2.2.8 LARGE SIGNAL STABILITY

The Attached Payload connected to Interface C shall maintain stability with the EPS interface by damping a transient response to 10 percent of the maximum response amplitude within 1.0 millisecond (ms) and remaining below 10 percent thereafter when the rise time/fall time (between 10 and 90 percent of the amplitude) of the input voltage pulse is less than 10 microseconds (s) and the voltage pulse is varied from 100 to 150 μs in duration.

Note: Figure 3.2.2.2.8–1 is used to clarify the above requirement.

3.2.2.3 ELECTRICAL POWER CONSUMER CONSTRAINTS

3.2.2.3.1 WIRE DERATING

Derating criteria for loads at and downstream of the Attached Payload Port Interface (APPI) shall be per NASA TM 102179, Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits, as interpreted by NSTS 18798, TA–92–038.

3.2.2.3.2 EXCLUSIVE POWER FEEDS

Attached Payloads shall utilize power feeds dedicated to a specific S3/P3 attach site location only. This prohibits intra–payload cabling between adjacent S3/P3 attach sites and the use of external power feeds powering integrated payload equipment attached to the S3/P3.

3.2.2.3.3 LOSS OF POWER

Payloads shall fail safe in the event of a total or partial loss of power regardless of the availability of keep alive power in accordance with NSTS 1700.7 ISS Addendum.

3.2.2.4 ELECTROMAGNETIC COMPATIBILITY

The Attached Payload connected to Interface C shall meet the EMC requirements of SSP 30243, Space Station Requirements for Electromagnetic Compatibility, paragraphs 3.1 and 3.6.2.

3.2.2.4.1 ELECTRICAL GROUNDING

The Attached Payload connected to Interface C shall meet all requirements specified in section 3 of SSP 30240.

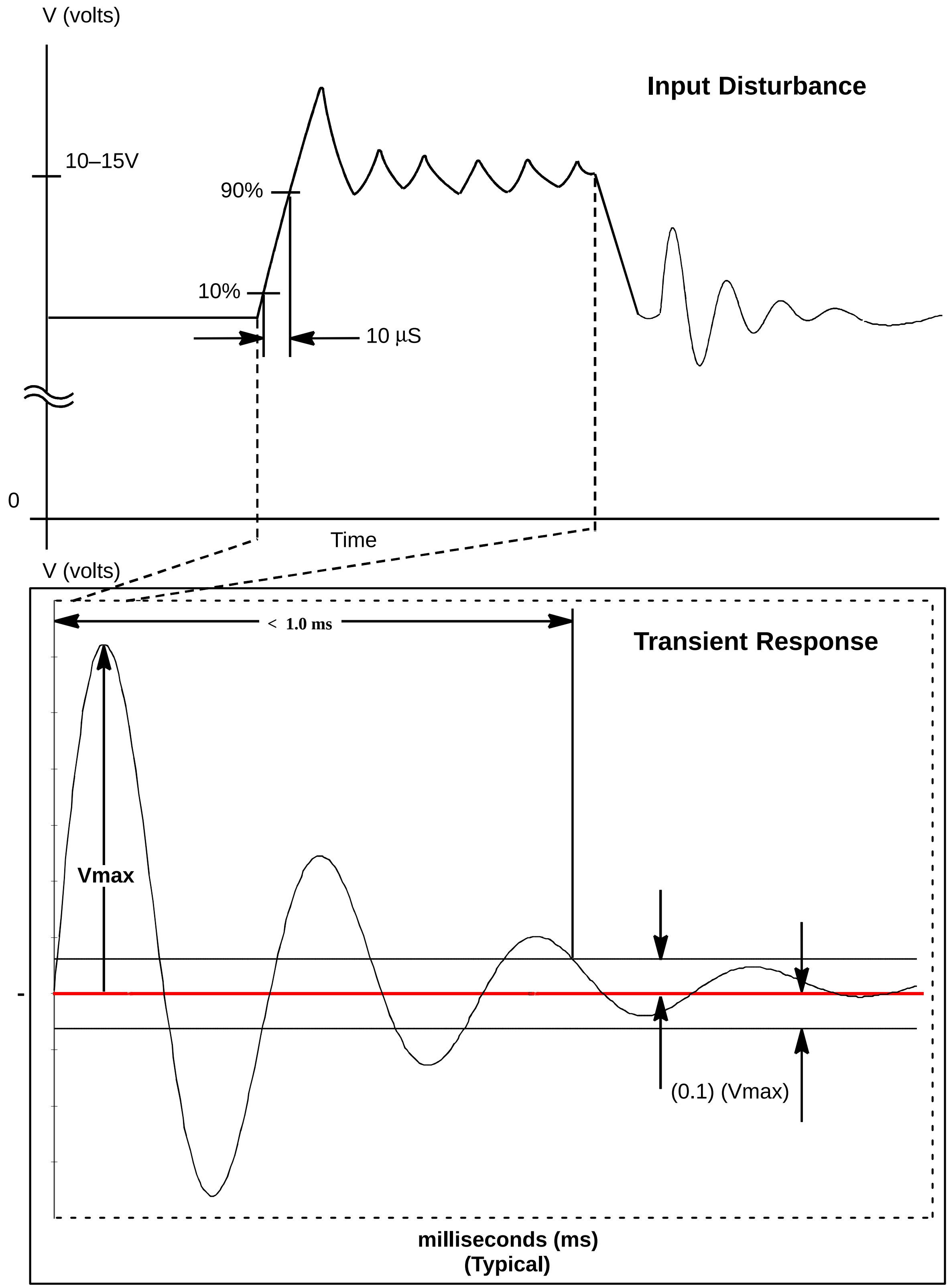


FIGURE 3.2.2.2.8–1 PULSE APPLIED TO THE POWER INPUT OF THE INTEGRATED ATTACHED PAYLOAD OR ELECTRICAL POWER CONSUMING EQUIPMENT

3.2.2.4.2 ELECTRICAL BONDING

Electrical bonding of the Attached Payload connected to Interface C shall be in accordance with SSP 30245, Space Station Electrical Bonding Requirements, and NSTS 1700.7 ISS Addendum, Sections 213 and 220. Electrical bonding of the Attached Payload shall include providing a Class R electrical bond at the Attached Payload Guide Pin interface with the Guide Vane Assembly at the final berthed position, for the fully mated, preloaded and deflected system.

3.2.2.4.3 CABLE/WIRE DESIGN AND CONTROL REQUIREMENTS

Cabling between payload Electrical Power Consuming Equipment (EPCE) and Interface C shall meet all cable and wire design requirements of SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility.

3.2.2.4.4 ELECTROMAGNETIC INTERFERENCE

Attached Payloads shall meet all Electromagnetic Interference (EMI) requirements of SSP 30237.

Alternately, Attached Payloads may choose to accept a minimal increase of EMI risk with a somewhat less stringent Electrical Field Radiated Susceptibility (RS03) requirement on equipment considered to be non–safety critical to the vehicle and crew. The tailored RS03 requirement, shown below, will hereafter be denoted RS03PL.

FREQUENCY	RS03PL LIMIT (V/m)
14 KHz – 400 MHz	5
400 MHz – 450 MHz	30
450 MHz – 1 GHz	5
1 GHz – 5 GHz	25
5 GHz – 6 GHz	60
6 GHz – 10 GHz	20
13.7 GHz – 15.2 GHz	25

3.2.2.4.5 ELECTROSTATIC DISCHARGE

A. Unpowered Attached Payload electrical components may be damaged by Electrostatic Discharge (ESD) equal to or less than 4,000 volts (V) to the case or any pin on external connectors.

B. Attached Payload EPCE that may be damaged by ESD between 4,000 and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. Labeling of Attached Payload EPCE susceptible to ESD up to 15,000 V shall be in accordance with MIL–STD–1686, Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Document. These voltages are the result of charges that may be accumulated and discharged from ground personnel or crewmembers during equipment installation or removal.

3.2.2.4.6 ALTERNATING CURRENT MAGNETIC FIELDS

The Attached Payload generated ac magnetic fields measured at a distance of 7 centimeters (cm) from the external surfaces of the Attached Payload shall not exceed 140 dB above 1 picotesla for frequencies ranging from 30 Hz to 2 kHz, then falling 40 dB per decade to 50 kHz.

3.2.2.4.7 DIRECT CURRENT MAGNETIC FIELDS

The Attached Payload generated dc magnetic fields shall not exceed 170 decibel (dB) picotesla at a distance of 7 cm from the external surfaces of the Attached Payload. This applies to electromagnetic and permanent magnetic devices.

3.2.2.4.8 CORONA

Attached Payload electrical and electronic subsystems, equipment, and systems shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC–STD–531, High Voltage Design Criteria.

3.2.2.4.9 ELECTROMAGNETIC INTERFERENCE SUSCEPTIBILITY FOR SAFETY-CRITICAL CIRCUITS

Attached Payload safety–critical circuits shall meet the margins defined in SSP 30243, paragraph 3.2.3.

3.2.2.5 SAFETY REQUIREMENTS

3.2.2.5.1 PAYLOAD ELECTRICAL SAFETY

The Attached Payload shall meet the electrical safety requirements as defined in NSTS 1700.7 ISS Addendum.

3.2.2.5.1.1 MATING/DEMATING OF POWERED CONNECTORS

Prior to mating or demating to/from the PAS/UCCAS active half, the Attached Payloads shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2–99–170, Crew Mating/Demating of Powered Connectors.

Note: The ISS can provide one verifiable upstream inhibit which removes voltage from the UMA connectors. The Attached Payload design shall provide the verification of the inhibit status at the time the inhibit is inserted.

3.2.2.5.1.2 SAFETY-CRITICAL CIRCUITS REDUNDANCY

The Attached Payload connected to Interface C shall meet the safety–critical circuits redundancy requirements defined in NSTS 18798.

3.2.2.5.2 POWER SWITCHES/CONTROLS

A. Switches/controls of the Attached Payload connected to Interface C performing on/off power functions shall open (dead–face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power–off position.

B. The Attached Payload power–off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit.

C. The Attached Payload standby, charging, or other appropriate nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition.

3.3 COMMAND AND DATA HANDLING INTERFACE REQUIREMENTS

Applicable paragraphs called out in the applicable documents shall be considered a part of this paragraph’s requirements.

3.3.1 COMMAND AND DATA HANDLING INTERFACE WITH MOBILE SERVICING SYSTEM

The Attached Payload requiring C&DH services while positioned on the MCAS shall be designed to interface with the MCAS active UMA to transmit and receive data from the ISS during MBS operations in accordance with SSP 42004, paragraph B3.2.2.6.

3.3.2 COMMAND AND DATA HANDLING INTERFACE WITH THE INTEGRATED TRUSS SEGMENT S3 PAYLOAD ATTACH SYSTEM AND P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

The Attached Payload requiring C&DH services from the ISS will be through the active UMA on the PAS or UCCAS. The PAS and UCCAS sites are Remote Terminals (RTs) to the payload Multiplexer–demultiplexer (MDM) which is internal to the USL. All C&DH requirements are a subset of those for the payload MDM and are derived from the requirements defined in SSP 57000.

3.3.2.1 WORD/BYTE NOTATIONS, TYPES, AND DATA TRANSMISSIONS

This paragraph applies to all Attached Payload commands and data on the Low Rate Data Link (LRDL) and all header data on the High Rate Data Link (HRDL) as stated in paragraph 3.3 of this document.

3.3.2.1.1 WORD/BYTE NOTATIONS

The Attached Payload connected to the S3 or P3 LRDL or HRDL shall use the word/byte notations as specified in SSP 52050, Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station, paragraph 3.1.1.

3.3.2.1.2 DATA TYPES

The Attached Payload connected to the S3 or P3 LRDL or HRDL shall use the data types as specified in SSP 52050, paragraph 3.2.1 or Appendix J, Legal Data Types in D684–10056–01, Prime Contractor Software Standards and Procedures Specification.

3.3.2.1.3 DATA TRANSMISSIONS

A. The Attached Payload transmitting data on the LRDL, MIL–STD–1553 bus shall use the data transmission order in accordance with D684–10056–01, Prime Contractor Software Standards and Procedures Specification, paragraph 3.4.

B. The Attached Payload transmitting data on the HRDL shall use the data transmission order in accordance with CCSDS 701.0–B–2, Advanced Orbiting Systems, Network and Data Links: Architectural Specification, Blue Book, paragraph 1.6.

3.3.2.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS

The Attached Payload must use the Consultative Committee for Space Data System (CCSDS) standards for space to ground and ground to space data and time requirements.

3.3.2.2.1 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA

A. Attached Payload data that is to be sent to the ground via the Ku–Band shall be CCSDS data packets.

B. The Attached Payload who have data that is transmitted ground to space or from the S3/P3 attach sites to the payload MDM shall utilize CCSDS data packets.

3.3.2.2.1.1 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA PACKETS

The Attached Payload shall develop data packets in accordance with SSP 52050, paragraph 3.1.3. CCSDS data packets consist of a primary header and a secondary header followed by the data field.

3.3.2.2.1.1.1 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS PRIMARY HEADER

The Attached Payload shall develop a CCSDS primary header in accordance with SSP 52050, paragraph 3.1.3.1.

3.3.2.2.1.1.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS SECONDARY HEADER

A. The Attached Payload shall develop a CCSDS secondary header immediately following the CCSDS primary header.

B. The CCSDS secondary header shall be developed in accordance with SSP 52050, paragraph 3.1.3.2 as tailored in Appendix D of SSP 52050.

3.3.2.2.1.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA FIELD

The Attached Payload CCSDS data field shall contain the Attached Payload data from the transmitting application to the receiving application and the CCSDS checksum in accordance with SSP 52050, paragraph 3.1.

3.3.2.2.1.3 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS APPLICATION PROCESS IDENTIFICATION FIELD

The CCSDS Application Process Identification (APID) is used for routing data packets as described in SSP 41175–02, Software ICD Part 1, Station Management and Control to ISS Book 2, General Interface Software Interface Requirements, paragraph 3.3.2.1.3. The format of APIDs is shown in SSP 41175–02, table 3.3.2.1.1–1.

Note: Telemetry APIDs for an Attached Payload are assigned by the payload engineering and integration function upon request from the payload and are recorded in the Attached Payload unique software ICD.

3.3.2.2.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS TIME CODES

3.3.2.2.2.1 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS UNSEGMENTED TIME

The Attached Payload shall use CCSDS unsegmented time code (CUC) in the secondary header as specified in CCSDS 301.0–B–2, CCSDS Time Code Format, paragraph 2.2.

3.3.2.2.2.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS SEGMENTED TIME

Segmented time code will be sent to the Attached Payload by a broadcast message on the payload MIL–STD–1553, Digital Time Division Command/Response Multiplex Data Bus. Segmented time code formats are specified in CCSDS 301.0–B–2, paragraph 2.4.

The broadcast time will be received at subaddress #29 on each payload MIL–STD–1553 bus.

The broadcast time signal will be updated once per second and is accurate to ±2.5 ms with respect to the Global Positioning System (GPS) receiver.

3.3.2.3 MIL–STD–1553 LOW RATE DATA LINK

A. The Attached Payload shall implement a single MIL–STD–1553 Remote Terminal (RT) to the payload unique MIL–STD–1553 bus.

B. Attached Payload MIL–STD–1553 RT bus addresses shall be in accordance with SSP 50193, Software Interface Control Document Part 1, Payload Multiplexer/Demultiplexer to International Space Station Book 1, Hardware Architecture Interface.

3.3.2.3.1 MIL–STD–1553 PROTOCOL

Attached Payload bus interface shall use MIL–STD–1553B for electrical characteristics and protocol.

3.3.2.3.1.1 STANDARD MESSAGES

A. The Attached Payload shall develop standard messages for the Payload MIL–STD–1553 in accordance with SSP 52050, paragraph 3.2.3.3.

B. MIL–STD–1553 subaddress assignments for standard messages shall be per SSP 52050, Table 3.2.3.2.1.4–1.

3.3.2.3.1.2 COMMANDING

A. The Attached Payload shall receive and process commands from the payload MDM that originate from the ground, timeliner, payload MDM and PCS in accordance SSP 52050, paragraph 3.2.3.4.

B. MIL–STD–1553 subaddress assignments for commands shall be per SSP 52050, Table 3.2.3.2.1.4–1.

3.3.2.3.1.3 HEALTH AND STATUS DATA

A. The Attached Payload shall develop health and status data in accordance with SSP 52050, paragraph 3.2.3.5.

B. The health and status data field format shall be developed in accordance with the data field format defined in SSP 57002, Attached Payload Software Interface Control Document Template, Table A–5.

C. The Attached Payload shall respond to the payload MDM polls to health and status data with updated data at a predefined rate of 1 Hz or 0.1 Hz.

3.3.2.3.1.4 SAFETY DATA

A. Safety data is the set of payload generated Caution and Warning (C&W) related parameters that are required to be available in the Command and Control System (CCS) MDM for S–band downlink, display to the crew on a core Portable Computer System (PCS), or monitored for C&W events. Determination of the safety–related parameters that are required is the responsibility of the Payload Developer/Payload Integrator. An example of safety–related data is a current or temperature sensor parameter which is being monitored for a situation that could lead to overheating. Safety data shall be included in the Health and Safety data CCSDS packets provided by the Attached Payload RTs.

B. The Attached Payload shall provide as safety data the standard caution and warning status words in accordance with SSP 52050, paragraph 3.2.3.5, and identify the safety data in SSP 57002, Table A–1.

3.3.2.3.1.4.1 CAUTION AND WARNING

For the purpose of C&W classifications, the sensors are the Attached Payload’s means of detecting events that were deemed necessary by the Payload Safety Review Panel (PSRP) during the phased safety reviews. The sensors used to produce C&W events are determined by the payload developer. Advisories may be set if the payload developer identifies a situation that meets the classification of an advisory.

3.3.2.3.1.4.1.1 CLASS 1 – EMERGENCY

All of the defined ISS emergency conditions are reported by the ISS systems. Attached Payloads and equipment will not report an emergency condition.

3.3.2.3.1.4.1.2 CLASS 2 – WARNING

Attached Payloads shall format the C&W word in accordance with SSP 52050, paragraph 3.2.3.5, as a warning when the Attached Payload sensors detect the following conditions:

A. A precursor event that could manifest to an emergency condition (open Ready to Latch indicator, over–pressurization of a pressure vessel, inadvertent release of a contaminant), and

   (1) automatic safing has failed to safe the event, or

   (2) the system is not automatically safed (i.e. requires manual intervention).

B. An event that results in the loss of a hazard control, and

   (1) automatic safing has failed to safe the event, or

   (2) the system is not automatically safed (i.e. requires manual intervention).

Note: A warning requires someone to take action immediately. Warnings are used for events that require manual intervention and for notification when automatic safing fails.

3.3.2.3.1.4.1.3 CLASS 3 – CAUTION

Attached Payloads shall format the C&W word in accordance with SSP 52050, paragraph 3.2.3.5, as a caution when the Attached Payload sensors detect the following conditions:

A. A precursor event that could manifest to an emergency condition (open Ready to Latch indicator, over pressurization of a pressure vessel, inadvertent release of a contaminant) and automatic safing has safed the event (i.e. the system does not require manual intervention).

B. An event that results in the loss of a hazard control and automatic safing has safed the event (i.e. the system does not require manual intervention).

Note: A caution requires no immediate action by the crew. Automatic safing has controlled the event.

3.3.2.3.1.4.1.4 CLASS 4 – ADVISORY

Attached Payloads that require an advisory shall format the C&W word in accordance with SSP 52050, paragraph 3.2.3.5, as an advisory. Advisories are set for the following conditions:

A. Advisories are set primarily for ground monitoring purposes (advantageous due to limited communication coverage and data recording).

B. Data item that most likely will not exist permanently in telemetry list but should be time tagged and logged for failure isolation, trending, or sustaining engineering.

3.3.2.3.1.5 SERVICE REQUESTS

The Attached Payload shall develop service requests in accordance with SSP 52050, paragraph 3.2.3.7. The service requests data format, shall be developed in accordance with SSP 52050, Table 3.2.3.7–1.

3.3.2.3.1.6 ANCILLARY DATA

Information regarding ancillary data that can be made available to payloads is contained in SSP 52050, paragraph 3.2.3.8. Attached Payloads which require ancillary data to be provided by the MDM shall be capable of receiving those parameters via Broadcast Ancillary Datasets or via Unique Ancillary Data Sets as described in paragraph 3.2.3.8, Ancillary Data of SSP 52050. The Attached Payload is to identify the need for such requirements via the development of the payload unique ICD per Appendix B of SSP 57002.

3.3.2.3.1.7 FILE TRANSFER

The Attached Payload requiring file transfer shall perform file transfers in accordance with SSP 52050, paragraph 3.2.3.9.

3.3.2.3.1.8 LOW RATE TELEMETRY

The Attached Payload requiring low rate telemetry shall develop low rate telemetry (i.e. science data) in accordance with SSP 52050, paragraph 3.2.3.10.

3.3.2.3.1.9 DEFINED MODE CODES

The Attached Payload MIL–STD–1553 mode codes are defined in SSP 52050, paragraph 3.2.3.2.1.5.

3.3.2.3.1.10 IMPLEMENTED MODE CODES

The Attached Payload shall implement MIL–STD–1553 mode codes in accordance with SSP 52050, paragraph 3.2.3.2.1.5 and Table 3.2.3.2.1.5–1.

3.3.2.3.1.11 ILLEGAL COMMANDS

If an illegal command occurs from the MIL–STD–1553, the Attached Payload shall respond to such illegal commands by setting the message error bit in the RT status word.

3.3.2.3.2 MIL–STD–1553 LRDL INTERFACE CHARACTERISTICS

3.3.2.3.2.1 LRDL CONNECTOR/PIN ASSIGNMENTS

The Attached Payload that interfaces with the MIL–STD–1553 bus to transmit data and/or receive commands shall utilize the connector and pin assignments for the UMA in accordance with SSP 57004, Attached Payload Hardware ICD Template, paragraph 3.2.1.

3.3.2.3.2.2 LRDL SIGNAL CHARACTERISTICS

A. The Attached Payload which requires connectivity to the payload local MIL–STD–1553 bus shall meet the electrical characteristics in accordance with MIL–STD–1553.

B. The Attached Payload MIL–STD–1553 bus shall meet the terminal characteristics in accordance with MIL–STD–1553, paragraph 4.5.2.

3.3.2.3.2.3 LRDL CABLING

A. The Attached Payload MIL–STD–1553 bus internal wiring characteristics for 75 Ohm or equivalent shall be in accordance with SSQ 21655, Cable, Electrical, MIL–STD–1553 Data Bus, Space Quality, General Specification. The Attached Payload MIL–STD–1553 bus internal wiring characteristics are summarized in Table 3.3.2.3.2.3–1.

TABLE 3.3.2.3.2.3–1 MIL–STD–1553 CABLE CHARACTERISTICS

Type	Twisted Shielded Pair
Characteristic Impedance	75 ± 5 Ohm
Cable Size	22 AWG or 24 AWG
Nominal wire–to–wire Capacitance	66 pf/m

B. The Attached Payload MIL–STD–1553 bus internal wiring stub length shall not exceed 10 feet (3.05 meters) when measured from the UMA active half connector to the Attached Payload/UCC MIL–STD–1553 RT.

3.3.2.4 HIGH RATE DATA LINK

3.3.2.4.1 PAYLOAD TO HIGH RATE FRAME MULTIPLEXER PROTOCOLS

The Attached Payload shall use the HRFM common protocols in accordance with SSP 50184, High Rate Data Link Physical Media, Physical Signaling & Protocol, paragraph 3.3.2.

3.3.2.4.2 HIGH RATE DATA LINK INTERFACE CHARACTERISTICS

3.3.2.4.2.1 PHYSICAL SIGNALING

Physical signaling of the HRDL shall be in accordance with SSP 50184, paragraph 3.0.

3.3.2.4.2.2 ENCODING

The Attached Payload using the HRDL shall encode data in accordance with SSP 50184, paragraphs 3.1.3 and 3.1.3.1, and Tables 3.1.3.1–1 and 3.1.3.2.

3.3.2.4.2.3 SYMBOLS USED IN TESTING

The Attached Payload using the HRDL shall provide the Halt symbol (H) for use in optical power tests in accordance with SSP 50184, Table 3.1.3.1–1.

3.3.2.4.3 HIGH RATE DATA LINK OPTICAL POWER

3.3.2.4.3.1 HIGH RATE DATA LINK TRANSMITTED OPTICAL POWER

The Attached Payload designed to provide HRDL services shall transmit a HRDL signal in accordance with SSP 50184 at a minimum average optical power of –16.33 dBm, as measured at the UMA interface in a stressed environment, and a minimum average optical power of –15.60

dBm, as measured at the UMA interface in an unstressed environment. The transmitted optical power shall be less than –9.0 dBm.

3.3.2.4.3.2 HIGH RATE DATA LINK RECEIVED OPTICAL POWER

The Attached Payload designed to provide HRDL services shall receive a HRDL signal in accordance with SSP 50184 at a minimum average optical power of –30.86 dBm, as measured at the UMA interface, in a stressed environment, and a minimum average optical power of –31.60 dBm, as measured at the UMA interface, in an unstressed environment. The received optical power shall be less than –9.0 dBm.

3.3.2.4.4 HIGH RATE DATA LINK FIBER OPTIC CABLE

The Attached Payload shall use fiber optic cable in accordance with SSQ 21654, Cable, Single Fiber, Multitude, Space Quality, General Specification for Document.

3.3.2.4.5 HIGH RATE DATA LINK FIBER OPTIC CABLE BEND RADIUS

The Attached Payload shall develop the routing, installation and handling procedures to assure the minimum bend radius of 2 inches or greater is maintained at all times for the fiber optic cable.

3.3.2.4.6 HIGH RATE DATA LINK CONNECTORS

The Attached Payload interfacing to the HRDL shall utilize the UMA passive half connector as defined in SSQ 21637.

3.3.2.4.7 HIGH RATE DATA LINK CONNECTOR/PIN ASSIGNMENTS

The Attached Payload that interfaces with the HRDL shall utilize the connector and pin assignments for the attach site UMA connector in accordance with SSP 57004, Attached Payload Hardware ICD Template, paragraph 3.2.1.

3.3.2.5 PORTABLE COMPUTER SYSTEM

The PCS is not supported at the S3/P3 attach sites. Attached Payloads who desire to utilize the PCS shall interface remotely through the MIL–STD–1553 in accordance with the requirements defined in SSP 57000, paragraphs 3.3.8.2 and 3.3.8.2.1.

3.4 PASSIVE THERMAL CONTROL INTERFACE REQUIREMENTS

3.4.1 PASSIVE THERMAL CONTROL INTERFACE WITH THE ITS S3 PAYLOAD ATTACH SYSTEM AND P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

3.4.1.1 PASSIVE THERMAL CONTROL DESIGN REQUIREMENTS FOR PAYLOAD ON THE ITS S3 PAS AND P3 UCCAS

The ITS S3 and ITS P3 passive thermal control interfaces are based on thermal analysis using The Boeing Company generated thermal math model provided to NASA in D684–10058–03–01, Integrated ISS Thermal Math Model, Volume 3, Book 1. The Attached Payload passive thermal control analysis shall be in accordance with the S3 thermal math model in D684–10058–03–01.

3.4.1.1.1 TEMPERATURE REQUIREMENT

The Attached Payload to the S3 PAS and P3 UCCAS interfaces shall meet all requirements specified when the structural interface temperature is within –120 Deg. F and +200 Deg. F.

3.4.1.1.2 DELETED

3.4.1.1.3 DELETED

3.4.1.1.4 DELETED

3.4.1.1.5 THERMAL RADIATION MODELS

A. Simplified thermal models of the Attached Payloads shall be provided to the ISS Program by the payload developer.

B. The Attached Payload simplified thermal models shall identify all surfaces over 10% specular and specularity values for those surfaces shall be provided.

3.4.1.1.6 THERMAL EXCHANGE BETWEEN PAYLOADS

A. Attached Payload active radiation surfaces (surfaces designed to reject heat generated by the payload) shall be oriented so that they have a cumulative view factor no greater than 0.1 to any surface of the generic attached payload operational envelope as defined in Figure 3.1.3.1.1.1–1 placed on any other S3 or P3 attach site. The view factor as used here is defined as the fraction of diffuse radiation leaving surface 1 that will fall on surface 2, such that:

$A_1F_{1-2} = A_2F_{2-1}$

Where A_1 = area of surface 1
A_2 = area of surface 2
F_{1-2} = view factor from surface 1 to surface 2
F_{2-1} = view factor from surface 2 to surface 1

B. Attached Payload surfaces with a view to other Attached Payloads shall have a specularity of 10% or less.

3.5 ENVIRONMENT INTERFACE REQUIREMENTS

3.5.1 ENVIRONMENT CONTROL INTERFACE WITH THE INTEGRATED TRUSS SEGMENT S3 PAYLOAD ATTACH SYSTEM AND P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

3.5.1.1 PRESSURE

The Attached Payload will be exposed to an on-orbit minimum pressure environment of 5.5E–12 pounds per square inch absolute (psia) (2.7E–10 Torr). This is to be used for design and analysis purposes.

3.5.1.2 THERMAL ENVIRONMENT

The Attached Payload will be exposed to thermal solar constants, albedo, and earth Outgoing Long-wave Radiation (OLR) environments as defined in Table 3.5.1.2–1; a space sink temperature of 3 K; the induced thruster plume environment and induced thermal environments from vehicle(s) docking and docked with the ISS; and thermal interactions with other on-orbit segments. Induced thermal effects on Attached Payloads due to beta angle extremes, orbital altitude, and attitude variation about the ISS vehicle axes are provided in Table 3.5.1.2–1. These environments are to be used for design and analysis purposes.

TABLE 3.5.1.2–1 HOT AND COLD NATURAL THERMAL ENVIRONMENTS

Case	Solar Constant (W/m2)	Earth Albedo	Earth Outgoing Long Wave Radiation (W/m^2)
Cold	1321	0.2	206
Hot	1423	0.4	286

TABLE 3.5.1.2–2 INDUCED THERMAL ENVIRONMENTS

Induced Environment	Assumed Parameters
Beta Angle	+/– 75°
Altitude	150 nmi. to 270 nmi.
Attitude Envelope Without Orbiter (1)	Any combination of +/–15° Roll (about X axis) (2) +/–15° Yaw (about Z axis) (2) +15 to –20° Pitch (about Y axis) (2)
Attitude Envelope With Orbiter Docked to ISS (1)	Any combination of +/– 15° Roll +/– 15° Yaw 0 to 25° Pitch

Note(s):

1) The attitude variations include variations in the Torque Equilibrium Attitude (TEA) as well as variations in the ISS attitude from the TEA attitude, both with Orbiter docked, and without Orbiter.

2) XYZ axes refer to ISS coordinate system orientation.

3.5.1.3 HUMIDITY

The Attached Payload will be exposed to an external environment of 0% relative humidity during on–orbit operations. This is to be used for design and analysis purposes.

3.5.1.4 ATOMIC OXYGEN

A. The Attached Payload will be exposed to a flux of 5.0 x 10E21 atoms per cm^2 per year for the on-orbit exposure duration. This is to be used for design and analysis purposes.

Note: The Atomic Oxygen (AO) environment is not applicable to Attached Payload internal surfaces and equipment, except where exposed to the external AO environment during ISS operations.

B. Surfaces exposed 30 days or less will be exposed up to 4.4 x 10E19 atoms per cm^2 per day. This is to be used for design and analysis purposes.

3.5.1.5 EXTERNAL CONTAMINATION REQUIREMENTS

The Attached Payload will be exposed to on–orbit external contamination environments as defined in SSP 30426, External Contamination Control Requirements, paragraphs 3.4 and 3.5.

3.5.1.5.1 MOLECULAR COLUMN DENSITY FROM VENTING, LEAKAGE AND OUTGASSING

The contribution to the molecular column density created by an Attached Payload along any unobstructed line of sight shall not exceed 1 x 10^{+14} molecules/cm^2 for any individual species, when viewed from any other Attached Payload location.

3.5.1.5.2 MOLECULAR DEPOSITION FROM MATERIALS OUTGASSING AND VENTING

A. Attached Payloads and their component materials exposed to space vacuum (which includes any internal materials within a non–pressurized shell as well as external materials) and vents shall not produce a cumulative contaminant deposit in excess of 1×10^{-14} gm/cm^2/sec on other Attached Payloads using the nominal operating temperature of the contamination source materials (emitters) and nominal operating temperatures of other Attached Payloads (receivers).

B. Attached Payloads and their component materials exposed to space vacuum (which includes any internal materials within a non–pressurized shell as well as external materials) and vents shall not produce a cumulative contaminant deposit in excess of 1×10^{-15} gm/cm^2/sec on ISS elements using the nominal operating temperatures of the contamination source materials (emitters) and nominal operating temperatures of ISS external contamination sensitive surfaces (receivers).

3.5.1.5.3 PARTICULATES

Attached payloads shall limit any active venting release of particulates to less than 100 microns in size.

3.5.1.6 ELECTROMAGNETIC RADIATION

Attached Payload EMC design will be exposed to the environment as specified in SSP 30243, paragraph 3.2.3, including applicable references. This is to be used for design and analysis purposes.

3.5.1.7 PLASMA

The Attached Payload will be exposed to an on–orbit natural plasma environment as specified in SSP 30425, section 5.0 and the induced plasma environment as specified in SSP 30420, Space Station Program Induced Plasma Environment, paragraph 3.3. The difference between the Attached Payload structure floating potential and the local plasma potential does not exceed +/-40 volts. This is to be used for design and analysis purposes.

3.5.1.8 IONIZING RADIATION

3.5.1.8.1 ATTACHED PAYLOAD CONTAINED OR GENERATED IONIZING RADIATION

Attached Payloads containing or using radioactive materials or that generate ionizing radiation shall comply with NSTS 1700.7 ISS Addendum, paragraph 212.1.

3.5.1.8.2 IONIZING RADIATION DOSE

Attached Payloads shall be designed to not produce an unsafe condition or one that could cause damage to external equipment as a result of exposure to a total dose specified in SSP 30512, Ionizing Radiation Design Environment, paragraph 3.1.2.

3.5.1.8.3 NOMINAL SINGLE EVENT EFFECTS IONIZING RADIATION

Attached Payloads shall be designed to operate in and to not produce an unsafe condition or one that could cause damage to other equipment as a result of exposure to the radiation dose environment specified in SSP 30512, paragraph 3.2.1.

3.5.1.8.4 EXTREME SINGLE EVENT EFFECTS

Attached Payloads shall be designed to not produce an unsafe condition or one that could cause damage to external equipment as a result of exposure to extreme Single Event Effect (SEE) ionizing radiation assuming exposure levels specified in SSP 30512, paragraph 3.2.2.

3.5.1.9 SOLAR ULTRAVIOLET RADIATION

The Attached Payload will be exposed to an on–orbit solar ultraviolet radiation environment as specified in SSP 30425, paragraph 7.2. This is to be used for design and analysis purposes.

3.5.1.10 PLUME IMPINGEMENT

Attached Payloads and exposed secondary structure (e.g., MLI blankets) will be exposed to the maximum effective normal pressure of 3.42 psf and shear plume impingement pressure of 0.80 psf to be used for design and analysis purposes.

3.5.1.11 METEOROIDS AND ORBITAL DEBRIS

The Attached Payload will be exposed to the M/OD environments as specified in SSP 30425, paragraph 8.0. Parameters of ISS M/OD environments definition are given in Table 3.5.1.11–1 and NASA TM 104825. This is to be used for design and analysis purposes.

TABLE 3.5.1.11–1 PARAMETERS FOR METEOROIDS AND ORBITAL DEBRIS ENVIRONMENTS DEFINITION

Altitude	215 nautical miles (400 km)
Orbital inclination	51.6 degrees
Space Station attitude	LVLH 10% of the time (Orbiter attached) TEA 90% of the time (Orbiter not attached)
Solar flux	70 x 10^4 Jansky ($F_{10.7}$ – 70)
Orbital debris density (1)	2.8 gm/cm^3
Maximum debris diameter (2)	20 cm
Note: (1) For M/OD critical items (see 6.1) only. (2) High degree of confidence of collision avoidance for this size and larger orbital debris objects.	

3.5.1.12 ACCELERATION ENVIRONMENT

A. The AP/UCC shall meet structural integrity requirements in an on–orbit acceleration environment having peak transient accelerations of up to 0.2 g’s, a vector quantity acting in any direction. This criteria is to be used as a component load factor and assumes that the payload mass and center of gravity are within the envelope defined in 3.1.3.1.2.2. This acceleration is not intended to be used to calculate interface loads.

B. During payload installation, the AP/UCC shall meet structural integrity requirements having peak transient accelerations of up to 0.4 g’s, a vector quantity in any direction. This criteria is to be used to assess the effects of the impact during payload installation. This acceleration is not intended to be used to calculate interface loads.

3.5.1.13 VIBRATION ENVIRONMENT

Attached Payload components weighing less than 300 lbm shall be designed to withstand the on–orbit linear peak vibration levels specified in Figure 3.5.1.13–1.

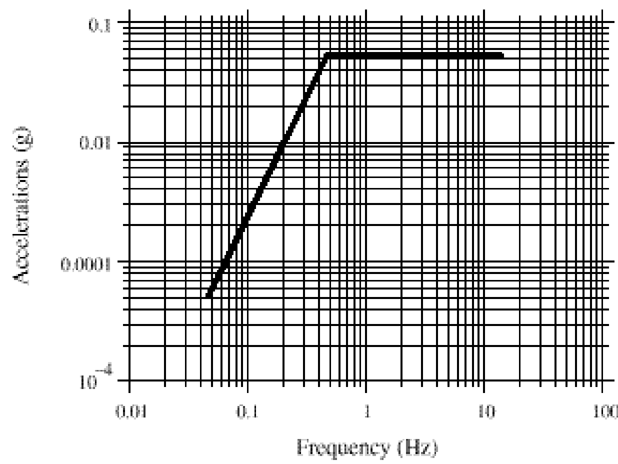


FIGURE 3.5.1.13–1 GENERAL ON–ORBIT OPERATIONAL TRANSLATIONAL VIBRATION ENVELOPE

3.6 MATERIALS AND PARTS INTERFACE REQUIREMENTS

3.6.1 MATERIALS AND PARTS USE AND SELECTION

Materials and processes used in the design and fabrication of the Attached Payload facility and associated support hardware shall comply with NSTS 1700.7 ISS Addendum.

3.6.1.1 THERMAL VACUUM STABILITY

Non–metallic materials exposed to space vacuum shall have low outgassing characteristics as defined by a total mass loss of < 1.0 percent and a volatile condensable material of < 0.1 percent when tested per ASTM–E595.

3.6.2 COMMERCIAL PARTS

Commercial Off The Shelf (COTS) parts used for Attached Payload hardware shall meet the requirements specified in NSTS 1700.7 ISS Addendum, paragraphs 208.3 and 209.

3.6.3 CLEANLINESS

Attached Payload hardware external surfaces shall conform to Visibly Clean–Standard (VC–S) as specified in SN–C–0005, NSTS Contamination Control Requirements Manual.

3.6.4 ATOMIC OXYGEN INTERACTION

Attached Payloads shall not utilize silver plated hardware. This is to prevent particulate generation from atomic oxygen interaction.

3.7 EXTRAVEHICULAR ROBOTICS REQUIREMENTS

3.7.1 EQUIPMENT REQUIRING SHUTTLE ROBOTIC SUPPORT

A. An Attached Payload requiring Shuttle Remote Manipulator System (SRMS) support may be subjected to an impulse as specified in NSTS 21000–IDD–ISS, paragraph 14.4.1.6, for imparted impulse at the Grapple Fixture (GF) to payload interface.

B. An Attached Payload requiring SRMS support shall provide a clearance zone from the GF centerline in accordance with NSTS 21000–IDD–ISS, paragraph 14.4.2.

C. An Attached Payload requiring SRMS support shall accommodate the GF in accordance with NSTS 21000–IDD–ISS, paragraph 14.4.1.1, 14.4.1.2 and 14.4.3.

D. An Attached Payload requiring SRMS support shall define the location of the GF in the unique Attached Payload hardware ICD.

E. An Attached Payload requiring SRMS support shall be within the certified mass handling capacity of the SRMS in accordance with the payload mass noted in NSTS 21000–IDD–ISS, paragraph 14.1.5.

F. An Attached Payload requiring SRMS support may be subjected to the load cases shown in NSTS 21000–IDD–ISS, paragraph 14.4.5.1, when torsion moment and bending moments are applied simultaneously.

G. The vibration frequency of an Attached Payload requiring SRMS support shall be in accordance with NSTS 21000–IDD–ISS, paragraph 14.4.5.2.

H. An Attached Payload requiring SRMS support shall electrically interface with the GF's ground strap whose length, gauge, and general outline are in accordance with NSTS 21000–IDD–ISS, paragraph 14.4.6, and SSP 30245, sections 3.2.1.3, 3.3, and 4.0.

I. An Attached Payload requiring SRMS support shall provide thermal isolation between the payload and the GF by installing the thermal isolation washers and bushings provided with the GF in accordance with NSTS 21000–IDD–ISS, Figure 14.4.7.4–1.

J. An Attached Payload requiring SRMS support shall provide scuff plates in accordance with NSTS 21000–IDD–ISS, Figure 3.3.1.1.2.2.2–1.

K. An Attached Payload requiring SRMS support shall shield critical and hazardous components from contact with other objects during robotic operations.

L. An Attached Payload requiring SRMS support and that is being robotically manipulated may be subjected to 0.11 feet per second contact between it and another object.

M. Attached Payload (requiring SRMS support) berthing mechanisms shall have a capture envelope larger than the SRMS placement accuracy specified in Table 3.7.1–1 when using just the SRMS.

N. An Attached Payload requiring SRMS support shall provide ready to latch indication to positively indicate when the two pieces of equipment are placed within the berthing mechanism's capture envelope.

TABLE 3.7.1–1 NATIONAL SPACE TRANSPORTATION SYSTEM REMOTE MANIPULATOR SYSTEM AND SPACE STATION REMOTE MANIPULATOR SYSTEM PLACEMENT ACCURACY

Position alignment	
Axial alignment	maximum of 1.9 inch separation (4)
Lateral alignment	0.0 +/– 0.5 inch
Angular alignment	
Roll, Pitch, and Yaw axis	0.0 +/– 0.25 degrees

Notes:
(1) All misalignment conditions can occur simultaneously.
(2) The measurement frame used for the conditions of this table has its origin on the Payload side of the mating interface in the center of the alignment guides and on the leading edge of the alignment guides. The orientation of the measurement frame is such that the X axis is perpendicular to the mating interface. Orientation of the Y and Z axes is arbitrary.
(3) The unaided placement accuracy described applies when a trained operator is actively controlling the robotic payload with a nominally operating SRMS and SSRMS, the Orbiter RCS jets inactive, and the ISS RCS jets inactive.
(4) Separation distance is between mating interface plane center to center.

3.7.2 EXTERNAL EQUIPMENT REQUIRING ROBOTIC HAND–OFF

An Attached Payload requiring robotic hand–off shall be equipped with a minimum of one GF for each robot; the GF must meet the requirements of the robot using it.

3.7.3 EXTERNAL EQUIPMENT REQUIRING SPACE STATION REMOTE MANIPULATOR SYSTEM SUPPORT

A. An Attached Payload requiring Space Station Remote Manipulator System (SSRMS) support shall interface with the SSRMS Latching End Effector (LEE) using a Power Data

Grapple Fixture (PDGF), a Power Video Grapple Fixture (PVGF) or a Shuttle GF that is compatible with the SSRMS LEE as specified in SSP 42004, Table 1.4.1.2–1. The GF to SSRMS LEE is an internal interface to the robotic subsystem.

B. An Attached Payload requiring SSRMS support shall be within the robotic payload properties of Table 3.7.3–1.

C. An Attached Payload requiring SSRMS support may be subjected to the contact conditions specified in Table 3.7.3–2, but is not required to capture (berth) during impact.

D. An Attached Payload requiring SSRMS support and not using the SSRMS programmable force/moment accommodation capability, shall provide capture, berthing, and closure drive capability to overcome the backdrive thresholds (static friction) defined in Table 3.7.3–3 and complete the closure of the capture and berthing operation when the SSRMS is limp per Note (1) of the table.

E. An Attached Payload requiring SSRMS support shall provide ready to latch indication to positively indicate when the two pieces of equipment are placed within the berthing mechanism's capture envelope.

F. An Attached Payload requiring SSRMS support in the Shuttle cargo bay shall provide scuff plates in accordance with NSTS 21000–IDD–ISS, paragraph 3.3.1.1.2.2.2 and Figure 3.3.1.1.2.2.2–1, to limit motion in the Orbiter port and starboard directions during berthing and unberthing from the Orbiter.

G. An Attached Payload requiring SSRMS support shall shield critical and hazardous components from contact with other objects during robotic operations.

H. An Attached Payload located within 2 feet of equipment that will be robotically manipulated may be subjected to contact conditions specified in Table 3.7.3–2, where the contact is between it and equipment being robotically manipulated.

I. An Attached Payload requiring SSRMS support shall be designed such that its needs for programmable backdrive after initial contact are within the SSRMS programmable force/moment accommodation capability of Table 3.7.3–4, when the SSRMS elbow joint angle is not less than 60 degrees from straight–arm configuration and the maximum distance between the GF and the berthing contact point is 14.76 ft (4.5 m).

J. An Attached Payload (requiring SSRMS support) berthing mechanisms shall have a capture envelope larger than the SSRMS placement accuracy specified in Table 3.7.1–1 when using just the SSRMS.

K. An Attached Payload requiring SSRMS support shall define the location of the GF in the unique Attached Payload hardware ICD.

TABLE 3.7.3–1 MOBILE SERVICING CENTER ROBOTIC PAYLOAD PROPERTIES

Maximum Payload Mass lbm (kg)	Maximum Inertia (1) x 1,000 lbm–ft^2 (kg–m^2)	Maximum CG Offset (2) (4) ft (m)	Maximum Diameter ft (m)	Maximum Length ft (m)	Minimum Frequency (3) Hz
46,077 (20,900)	10,678 (450)	24 (7.3)	50 (15.2)	50 (15.2)	0.18

Notes:
(1) Moments of inertia are expressed about the payload CG in the payload principal axes and about any axis.
(2) Vector from the origin of End Effector Operating Coordinate System (EEOCS) as defined in SSP 30219, Figure 8.0–10, to payload center of gravity, expressed in EEOCS.
(3) Minimum payload frequency, assuming that the grapple fixture is held rigid.
(4) SSRMS maneuverability and velocity increases as robotic payload CG offset is reduced, the robotic payload CG offset should be minimized.

TABLE 3.7.3–2 BERTHING CONTACT CONDITIONS

Closing velocity	
Maximum Axial (x axis) velocity	0.10 feet per second (fps)
Lateral velocity (y and z axis)	0.0 +/– 0.10 fps
Angular velocity	
Roll axis	0.0 +/– 0.20 degrees per second
Pitch and Yaw axis	0.0 +/– 0.20 degrees per second

Notes:
(1) All velocity conditions are to be applied simultaneously. The velocities are combined for lateral as the rss of the two axes.
(2) The contact conditions described apply when a trained operator is actively controlling the payload with a nominally operating SSRMS with the Orbiter Reaction Control System (RCS) jets and the ISS RCS jets inactive.

TABLE 3.7.3–3 SPACE STATION REMOTE MANIPULATOR SYSTEM BACKDRIVE THRESHOLD

Maximum Force (1) (2)	49.458 lbf (220N)
Maximum Moment (1) (3)	147.512 ft–lbf (200 Nm)

Notes:
(1) The SSRMS will back drive when the forces and moments applied by the robotic payload to the tip of the SSRMS reach the values shown in this table, when the SSRMS is in limp mode (no motor drive current and the joint brakes are off) and the elbow joint angle is not less than 15 degrees from the straight arm configuration.
(2) Force in any direction.
(3) Moment about any axis.

TABLE 3.7.3–4 FORCE/MOMENT ACCOMMODATION

Force (1) (2)	
Range	6.74 lbf (30 N) to 100 lbf (445 N)
Resolution	1.1 lbf (5 N)
Accuracy	10 percent or 6.74 lbf (30 N), whichever is greater
Moment (1) (3)	
Range	11.061 ft–lbf (15 Nm) to 300 ft–lbf (407 Nm)
Resolution	1.47 ft–lbf (2 Nm)
Accuracy	10 percent or 11.061 ft–lbf (15 Nm), whichever is greater

Notes:
(1) The SSRMS will back drive when the forces and moments applied by the robotic payload to the tip of the SSRMS reach the values shown in this table, when the SSRMS is in limp mode (no motor drive current and the joint brakes are off) and the elbow joint angle is not less than 15 degrees from the straight arm configuration.
(2) Force in any direction.
(3) Moment about any axis.

3.7.3.1 EQUIPMENT REQUIRING SSRMS SUPPORT USING A NATIONAL SPACE TRANSPORTATION SYSTEM GRAPPLE FIXTURE

A. An Attached Payload requiring SSRMS support shall provide a clearance envelope around the GF as specified in SSP 42004, paragraph I3.2.2.1.

B. An Attached Payload requiring SSRMS support shall accommodate the GF in accordance with SSP 42004, section I3.2.2.2.

C. An Attached Payload requiring SSRMS support will be subject to the MBS POA and SSRMS tip loads as defined in SSP 42004, section A3.2.2.3.

D. An Attached Payload requiring SSRMS support will be subjected to an impulse as specified in SSP 42004, section I3.2.2.3.1.

E. The vibration frequency of an Attached Payload requiring SSRMS support shall be in accordance with SSP 42004, section A3.2.2.3.2.

F. An Attached Payload requiring SSRMS support shall provide thermal isolation between the payload and the GF by installing the thermal isolation washers and bushings provided with the GF in accordance with NSTS 21000–IDD–ISS, Figure 14.4.7.4–1.

G. An Attached Payload requiring SSRMS support shall electrically interface with the GF’s in accordance with SSP 42004, section I3.2.2.5.1.

3.7.3.2 EQUIPMENT REQUIRING SPACE STATION REMOTE MANIPULATOR SYSTEM SUPPORT USING A POWER DATA GRAPPLE FIXTURE

A. An Attached Payload requiring SSRMS support shall provide a clearance envelope as specified in SSP 42004, paragraph A3.2.2.1.

B. An Attached Payload requiring SSRMS support shall provide a structural and mechanical interface in accordance with SSP 42004, paragraph A3.2.2.2 and section A3.2.2.3, and NSTS 21000–IDD–ISS, Figure 14.4.3–2, sheets one and two.

C. An Attached Payload requiring electrical power from the SSRMS shall interface with the PDGF in accordance with SSP 42004, paragraphs A3.2.2.5 and A.3.2.2.5.2.

D. An Attached Payload requiring electrical power from the SSRMS shall operate from electrical power provided in accordance with SSP 42004, paragraph A3.2.2.5.1.

E. An Attached Payload requiring data from the SSRMS shall interface with the PDGF in accordance with SSP 42004, section A3.2.2.6.

F. An Attached Payload requiring video interface with the SSRMS shall interface with the PDGF in accordance with SSP 42004, section A3.2.2.7.

G. An Attached Payload requiring electrical interface with the SSRMS shall accommodate the PDGF harness and provide connectors in accordance with SSP 42004, section A3.2.2.4.

H. An Attached Payload requiring SSRMS support shall limit the thermal conductance from the payload to the PDGF in accordance with SSP 42004, paragraph A3.2.2.8.1.

I. An Attached Payload requiring SSRMS support shall comply with the electromagnetic effects of SSP 42004, section A3.2.2.9.1.

3.7.3.3 EQUIPMENT REQUIRING SPACE STATION REMOTE MANIPULATOR SYSTEM SUPPORT USING A POWER VIDEO GRAPPLE FIXTURE (PVGF)

A. An Attached Payload requiring SSRMS support shall provide a clearance envelope as specified in SSP 42004, paragraph **(TBD #7)**.

B. An Attached Payload requiring SSRMS support shall provide a structural and mechanical interface in accordance with SSP 42004, paragraph **(TBD #8)**.

C. An Attached Payload requiring electrical power from the SSRMS shall interface with the PVGF in accordance with SSP 42004, paragraphs **(TBD #9)**.

D. An Attached Payload requiring electrical power from the SSRMS shall operate from electrical power provided in accordance with SSP 42004, paragraph **(TBD #10)**.

E. An Attached Payload requiring data from the SSRMS shall interface with the PVGF in accordance with SSP 42004, section **(TBD #11)**.

F. An Attached Payload requiring video interface with the SSRMS shall interface with the PVGF in accordance with SSP 42004, section **(TBD #12)**.

G. An Attached Payload requiring electrical interface with the SSRMS shall accommodate the PVGF harness and provide connectors in accordance with SSP 42004, section **(TBD #13)**.

H. An Attached Payload requiring SSRMS support shall limit the thermal conductance from the payload to the PVGF in accordance with SSP 42004, paragraph **(TBD #14)**.

I. An Attached Payload requiring SSRMS support shall comply with the electromagnetic effects of SSP 42004, section **(TBD #15)**.

3.7.4 EXTERNAL EQUIPMENT REQUIRING DEXTEROUS ROBOTIC SUPPORT

A. An Attached Payload requiring dexterous robot support shall provide a dexterous handling interface in accordance with SSP 42004, section C3.2 (excluding 3.2.2.3.3), for Standard Dexterous Grasp Fixture (SDGF), on paragraphs within D3.2 for Micro–conical Fitting (MCF), or paragraph within G3.2 for bare bolt interfaces, or paragraphs within H3.2 (excluding 3.2.2.3.3), for Modified Micro–Fixtures or paragraphs within K3.2 for Modified MCFs.

B. An Attached Payload requiring dexterous robot support shall be within the mass properties, volume, and frequency limits specified in Table 3.7.4–1.

C. An Attached Payload requiring dexterous robot support shall be in accordance with SSP 30550, Volume 1, paragraphs 3.2.1.5, 3.2.2.4, 3.4.1.1 (excluding 3.4.1.1.5 and 3.4.1.1.6), 3.4.2.1.4, 3.4.2.1.5, 3.4.2.2 (excluding 3.4.2.2.1.3, 3.4.2.2.1.8, 3.4.2.2.1.10, 3.4.2.2.4, and 3.4.2.2.5), 3.4.3, 3.4.4.1.5, 3.4.4.1.6, 3.4.6, 3.4.7.2.1, 3.4.8.1.1.3, 3.4.9.2.1, 3.4.9.2.5, 3.4.9.2.6, 3.4.13, 3.4.15, 3.5.3.1, and 3.5.3.2 as modified by the following:

(1) Equipment designed to be actuated by dexterous robotic arm motion shall require actuation only along straight lines or a series of straight lines of motion.

(2) Equipment designed to be actuated by forces and moments provided by a dexterous robotic arm shall require less than or up to the forces and moments defined in Table 3.7.4–2 and the force directions defined in Figure 3.7.4–1.

D. Worksites associated with equipment that requires dexterous robotics support shall be designed in accordance with SSP 30550, Volume 1, paragraphs within 3.3.1.1., 3.3.1..4, 3.3.1.5, 3.3.3.3, 3.3.3.5, 3.4.10.1.2 and 3.4.10.1.4 as modified by the following:

(1) Worksites associated with dexterous equipment designed to be actuated by dexterous robotic arm motion shall require actuation only along straight lines or a series of straight lines of motion.

(2) Worksites associated with dexterous equipment designed to be actuated by forces and moments provided by a dexterous robotic arm shall require less than or equal to the forces and moments defined in Table 3.7.4–2 and the force directions defined in Figure 3.7.4–1.

E. The equipment requiring temporary storage on the dexterous robot shall be in accordance with SSP 42004, Section E.

TABLE 3.7.4–1 PAYLOAD PARAMETERS FOR DEXTEROUS OPERATIONS

Maximum Mass lbm (kg)	Maximum Inertia (1) lbm–ft^2 (kg–m^2)			Maximum CG Offset (2) ft (m)	Maximum Dimension ft (m)			Minimum Freq (3) (Hz)
	Ixx	Iyy	Izz	rss	X	Y	Z	
1320 (600)	1186 (50)	1186 (50)	1186 (50)	2.0 (0.61)	5.25 (1.6)	5.25 (1.6)	5.25 (1.6)	8

Notes:
(1) Moments of inertia are expressed about the payload CG in the payload principal axes.
(2) Vector from the origin of OTCMOCS as defined in SSP 30219, Figure 8.0–12, to payload center of gravity, expressed in OTCMOCS.
(3) Minimum payload frequency, assuming that the grasp fixture is held rigid.
(4) Tools used to grasp a payload are considered to be part of the payload.

TABLE 3.7.4–2 MAXIMUM FORCE AND MOMENT AVAILABLE AT TIP OF ORBITAL REPLACEMENT UNIT TOOL CHANGEOUT MECHANISM

Axial Force lbf (N)	Lateral Force lbf (N)	Moment about any axis lb–ft (N–m)
25 [111]	10 [45]	40 [54]

Note 1: Elbow pitch angle must be greater than 25 degrees.
Note 2: Maximum force and moment are not applied simultaneously.
Note 3: Axial and lateral directions are defined in Figure 3.7.4–1.

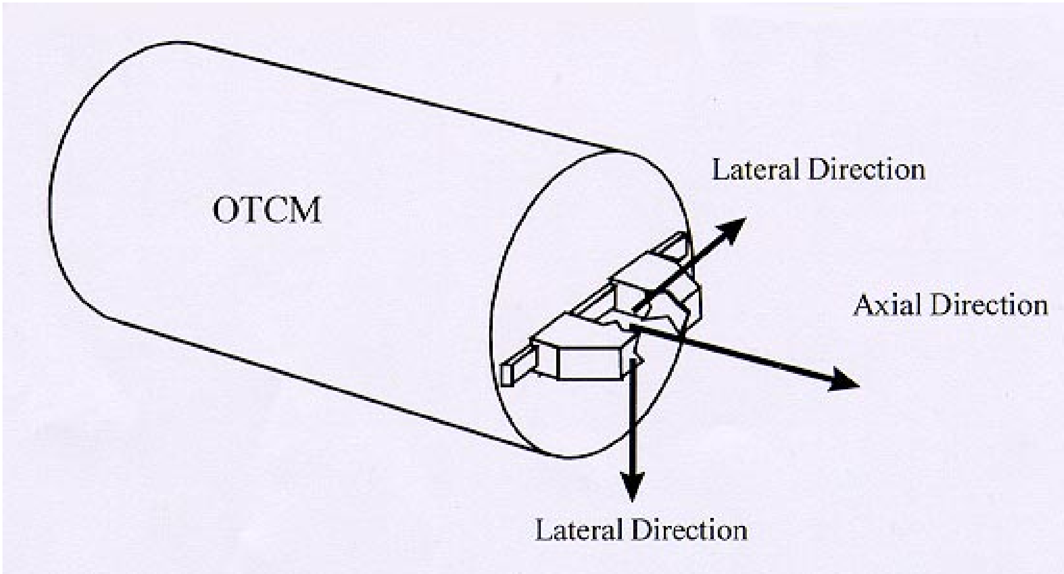


FIGURE 3.7.4–1 DEFINITION OF AXIAL AND LATERAL FORCE DIRECTIONS

3.7.5 EQUIPMENT REQUIRING ROBOTIC TRANSLATION

A. An Attached Payload requiring robotic translation support or temporary storage on the MSS shall be within the mass properties, volume, and frequency limits of Table 3.7.5–1 for translation by the SSRMS or payload/ORU Accommodation (POA) located on the Mobile Servicing Center (MSC). The translation in this section is defined as translating equipment along the MT rails driven by the MT.

B. The distance between the Attached Payload SSRMS GF and its POA GF shall not exceed 16.4 ft (5 m).

C. An Attached Payload requiring robotic translation support shall not require electrical power, data, or video from the SSRMS LEE, MCAS, or POA during translation.

D. An Attached Payload requiring robotic translation support shall comply with a robotics translation corridor as specified in SSP 41162, paragraph 3.2.2.7.

TABLE 3.7.5–1 PAYLOAD TRANSLATION AND TRANSPORT

Payload Location	Maximum Mass lbm (kg)	Maximum Inertia (1) x 1,000 lbm–ft^2 (kg–m^2)			Maximum CG Offset (2) ft (m)			Maximum Diameter ft (m)	Maximum Length ft (m)	Minimum Freq (3) (Hz)
		Ixx	Iyy	Izz	CGx	CGy	CGz			
SSRMS	11,023 (5,000)	NA	NA	NA	4.9 (1.5)	1.97 (0.6)	1.97 (0.6)	15 (4.6)	45 (13.7)	0.18
POA	46,077 (20,900)	1,305 (55)	10,678 (450)	10,678 (450)	23 (7.0)	7.5 (2.3)	7.5 (2.3)	15 (4.6)	45 (13.7)	0.18

Notes:
(1) Moments of inertia are expressed about the payload CG in the payload principal axes.
(2) Vector from the origin of EEOCS as defined in SSP 30219, Figure 8.0–10, to the payload CG expressed in EEOCS.
(3) Minimum payload frequency, assuming that the GF is held rigid.

3.7.6 EBCS AVIONICS PACKAGE

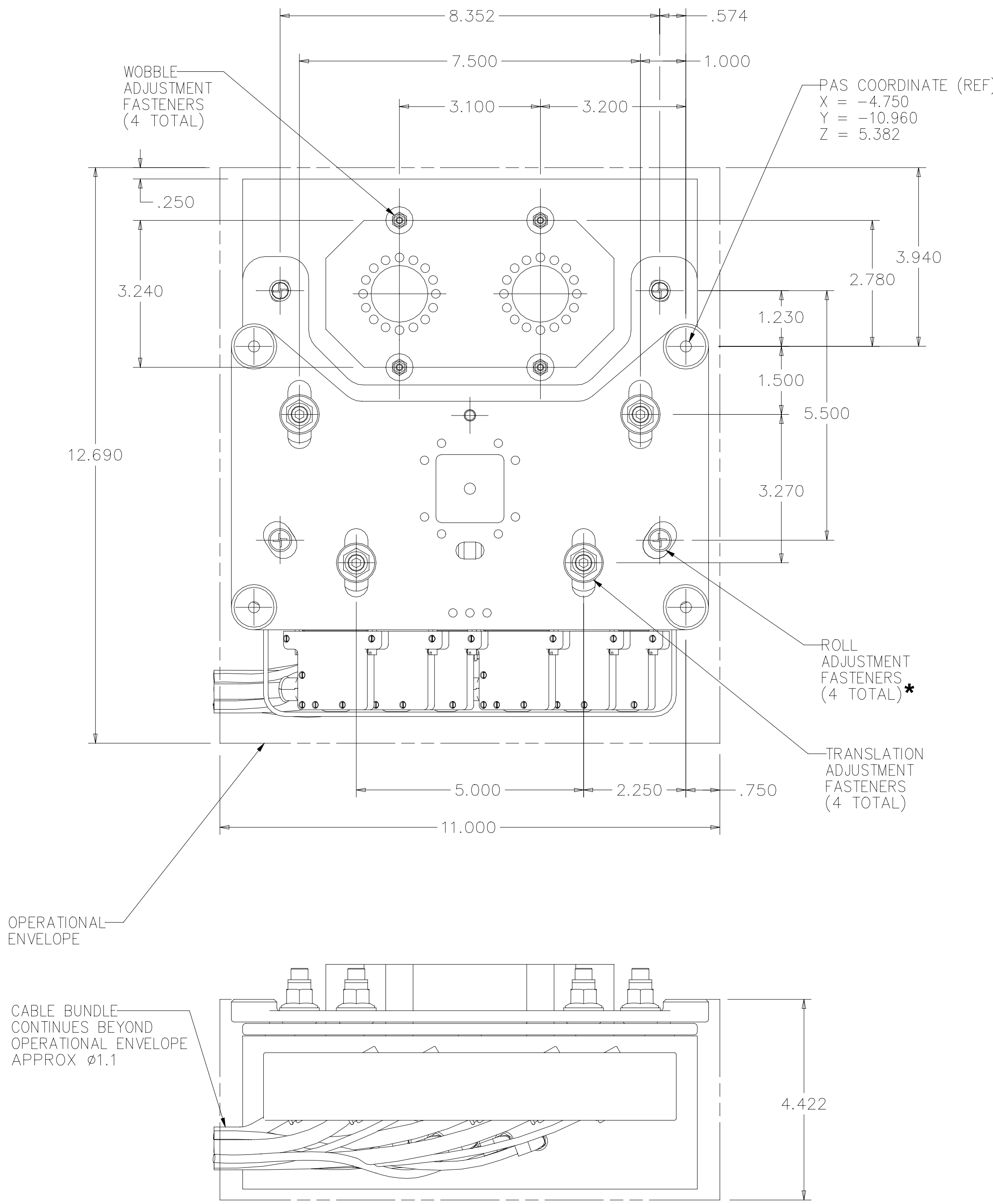
The Avionics Package, MDRobotics part number 202918–1, consists of two cameras, primary and backup, with a light emitting diode (LED) ring around each camera lens, video processing electronics housed in a chassis, circuits to route ISS power to the payload and an Avionics Package mount / adjustment assembly. The Avionics Package mass is 20 lbs and the Center of Gravity (C.G.) is located at X = 0.10 inches, Y = –12.97 inches and Z = 7.30 inches based on the PAS coordinate system. The Avionics Package mass does not include the PVGF cable. The mass/linear foot of the PVGF cable is 0.808 lbs/ft.

3.7.6.1 EBCS AVIONICS PACKAGE ENVELOPE AND MOUNTING

A. The payload developer shall accommodate the operational envelope, roll adjustments and optical keep–out zone for the EBCS Avionics Package as defined in Figures 3.7.6.1–1 and 3.7.6.1–2.

B. The payload shall locate the EBCS Avionics Package on the Payload as defined in SSP 57004, Figure 3.7.1–1 within an error envelope defined by +/–0.125 degrees about the X and Y axis, +/–0.2 inches for the Z axis and $L/0.182 + \alpha /0.4 = 1$, where L is the lateral offset in the X–Y plane in inches and α is degrees about the Z axis. These errors are measured from the plane defined by the PAS guide pins to the camera mounting interface. Misalignments are relative to the PAS local coordinate system shown in Figure 3.1.3.1.2.1–1 (when the payload is fully seated but prior to claw activation). This error envelope includes manufacturing and installation errors, as well as maximum possible measurement errors.

C. The payload shall maintain the location of the EBCS Avionics Package mounting surface as specified in B above, after exposure to vibration and impact loads and during exposure to the on–orbit thermal environment conditions specified herein.



*NOTE: 1” diameter access must be provided for roll lock locations, 4 places.

FIGURE 3.7.6.1–1 EBCS AVIONICS PACKAGE OPERATIONAL ENVELOPE

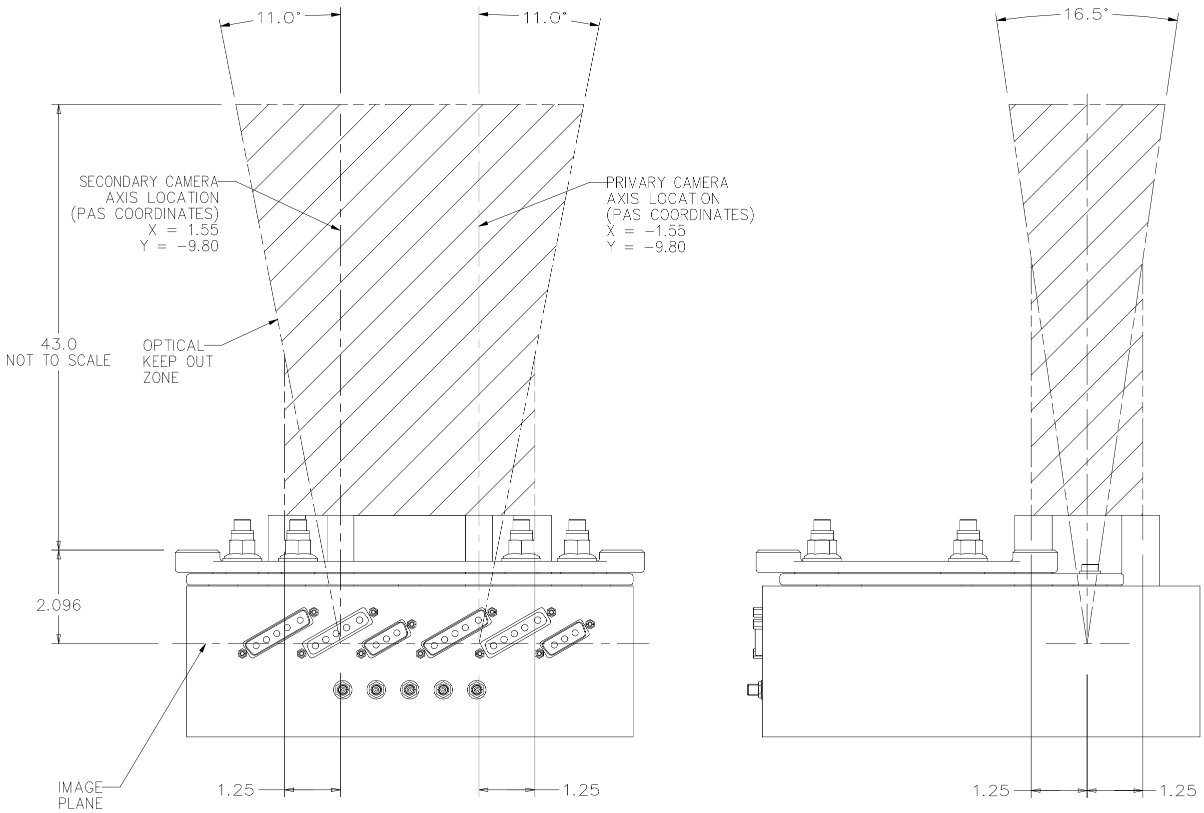


FIGURE 3.7.6.1–2 EBCS AVIONICS PACKAGE OPTICAL KEEP OUT ZONE

3.7.6.2 EBCS AVIONICS PACKAGE POWER

A. The payload shall route the PVGF cable to the EBCS Avionics Package and provide connections as indicated in SSP 57004, Figure 3.7.2–1. The Avionics Package uses power from the PVGF and also routes payload power from the PVGF to the payload, up to 1800 Watts if necessary.

The Avionics Package will receive 30 Watts, compatible with the MSS power quality requirements specified in SSP 42004, paragraph 3.2.1.5.1, during payload berth and unberth operations.

B. The payload shall provide 2 heater busses, each capable of delivering 25 W, to the Avionics Package for keep–alive heater power.

3.7.6.3 EBCS THERMAL REQUIREMENTS

A. EBCS Non–Operational On–Orbit

(TBD #16)

B. EBCS Operational On–Orbit

(TBD #16)

3.7.6.4 EBCS VIBRATION REQUIREMENTS

The payload shall not exceed the vibration limits in Table 3.7.6.4–1.

TABLE 3.7.6.4–1 EBCS AVIONICS PACKAGE VIBRATION LIMITS

Frequency (Hz)	Minimum Power Spectral Density for Flight Units (g^2/Hz)
20	0.010
80	0.040
115	0.040
165	0.040
250	0.040
350	0.040
500	0.033
2000	0.007
Overall RMS	6.1 g

3.7.6.5 EBCS AVIONICS PACKAGE VIDEO

The payload shall route the PVGF cable to the EBCS Avionics Package and provide connections as indicated in SSP 57004, Figure 3.7.2–1. The EBCS Avionics Package will receive ISS video and synchronization signals from the SSRMS via the PVGF.

3.8 EXTRAVEHICULAR ACTIVITY

A. Attached Payloads shall be designed such that all operations are performed via EVR with contingency EVA capability.

B. Attached Payloads shall be designed to the sharp edge, protrusion, and glove temperature requirements of NSTS 07700, Volume XIV, Appendix 7, even if EVA is not planned or anticipated.

3.8.1 EXTRAVEHICULAR ACTIVITY AS A BACKUP FOR ROBOTICS ACTIVITIES

A. EVA aids shall be provided in all locations necessary to support SSRMS based EVA contingency operations as specified in SSP 50005, paragraph 12.3.

B. All loose equipment and cargo operated on or by an EVA crewmember shall have attachment points or restraints so it can be secured or tethered at all times during transfer and at the worksite during EVA contingency operations as specified in SSP 50005, paragraph 12.3.

C. EVA worksites shall provide a force reaction mechanism within 24 inches of the task site when EVA operational forces greater than 10 lbf are anticipated. The force reaction mechanism shall be independent of the robot stabilization platform.

3.8.2 EXTRAVEHICULAR ACTIVITY TRANSLATION

The ISS truss provides a translation path to each of the six PAS/UCCAS sites for contingency support of the ORUs at the interface and contingency operations involving the PAS/UCCAS. These translation paths, in addition to the clearances specified in 3.8.2.1, allow for EVA contingency operations involving the PAS/UCCAS active half UMA, the three PAS/UCCAS guide vanes at each site, the PAS/UCCAS capture latch, the Attached Payload passive half UMA, and the Attached Payload EVA releasable capture bar.

Attached Payloads shall provide for EVA translation for contingency operations.

3.8.2.1 PAYLOAD ATTACH SYSTEM/UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM INTERFACE CLEARANCES

Attached Payloads shall be designed not to violate the PAS/UCCAS EVA access envelopes as defined by paragraph 3.1.3.1.1.3A to allow for attach site ORU removal and replacement.

3.8.2.2 EXTRAVEHICULAR ACTIVITY TRANSLATION CORRIDOR PROTRUSION

Attached Payloads impinging on EVA translation corridors and worksites shall provide EVA fixtures serving the same functions as those obscured by the payload as specified in SSP 50005, paragraph 14.5.3.

3.8.3 HUMAN ENGINEERING DESIGN

3.8.3.1 CREW ACCESS DIMENSIONS

The Attached Payload shall provide sufficient free volume for the crew per figures 3.8.3.1.1.1–1 and 3.9.1.7.1.1–1 to perform their contingency, operations, and maintenance tasks as well as accommodate tools and equipment used in these tasks.

3.8.3.1.1 BODY ENVELOPE AND REACH ACCESSIBILITY

Attached Payloads shall provide adequate volume to accommodate crew performance of tasks to ensure that tool utilization is sufficient to remove, replace, operate and maintain the payload equipment.

3.8.3.1.1.1 CENTERING

Attached Payload crew mobility aids or grasp points shall be designed to accommodate the 50th percentile American female to 95th percentile American male anthropometric measurements.

A. Crew mobility aids or grasp points shall be placed within 24 inches to the left or right of the body centerline when working in a foot restraint position as described in Figure 3.8.3.1.1.1–1.

B. Crew mobility aids or grasp points shall be placed within 18 inches above or below the center of the crewmember's optimum two–handed work envelope as described in Figure 3.8.3.1.1.3–1.

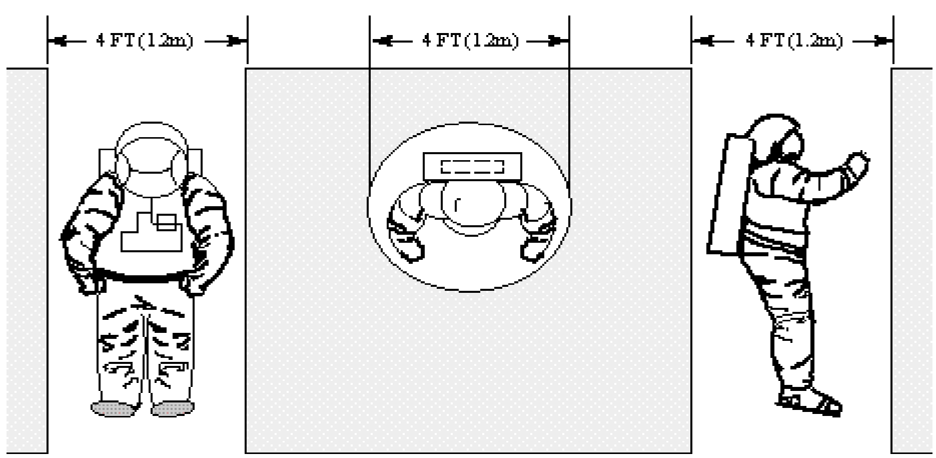


FIGURE 3.8.3.1.1.1–1 WORKING VOLUME FOR MANIPULATIVE EXTRAVEHICULAR ACTIVITY TASKS

3.8.3.1.1.2 EXTRAVEHICULAR ACTIVITY CREWMEMBER FIELD OF VIEW

Attached Payload equipment, displays, and markings required to be seen to perform EVA tasks shall be located within the field of view of the Extravehicular Mobility Unit (EMU) as defined in Figure 3.8.3.1.1.2–1.

3.8.3.1.1.3 EXTERNAL TASK LOCATION REQUIREMENTS

All tasks to be performed by a crewmember wearing a pressurized suit at dedicated worksites as defined in 3.8.1, shall be located per Figure 3.8.3.1.1.3–1.

3.8.3.2 STRENGTH REQUIREMENTS

3.8.3.2.1 EXTERNAL LIMIT LOADS

External components of Attached Payload hardware which will have a crew or crew actuated tool interface shall be operable by the loads defined in Table 3.1.1.2.6–2.

3.8.3.2.2 EXTRAVEHICULAR ACTIVITY ACTUATED CONTROLS

There shall be no EVA actuated controls on Attached Payloads.

3.8.3.3 MOBILITY AIDS AND RESTRAINTS

Attached Payload design shall be in accordance with the mobility aids requirements specified in SSP 50005, paragraph 11.8.

3.8.3.3.1 PROVIDE EXTRAVEHICULAR ACTIVITY HANDLES

All removable or portable payload units greater than 1 cubic foot in size shall be provided with handles or other suitable means for grasping, tethering, handling, and carrying.

3.8.3.3.1.1 EXTRAVEHICULAR ACTIVITY HANDHOLDS/HANDRAILS

A. EVA handholds/handrails design shall be in accordance with the requirements specified in SSP 30256:001, paragraph 3.6.1.

B. Handholds shall be oriented such that the plane formed by the handhold longitudinal axis and the cross–section major axis is parallel with the body torso frontal plane.

FIELD OF VIEW WITH EXTRAVEHICULAR VISOR ASSEMBLY (EVVA) ATTACHED

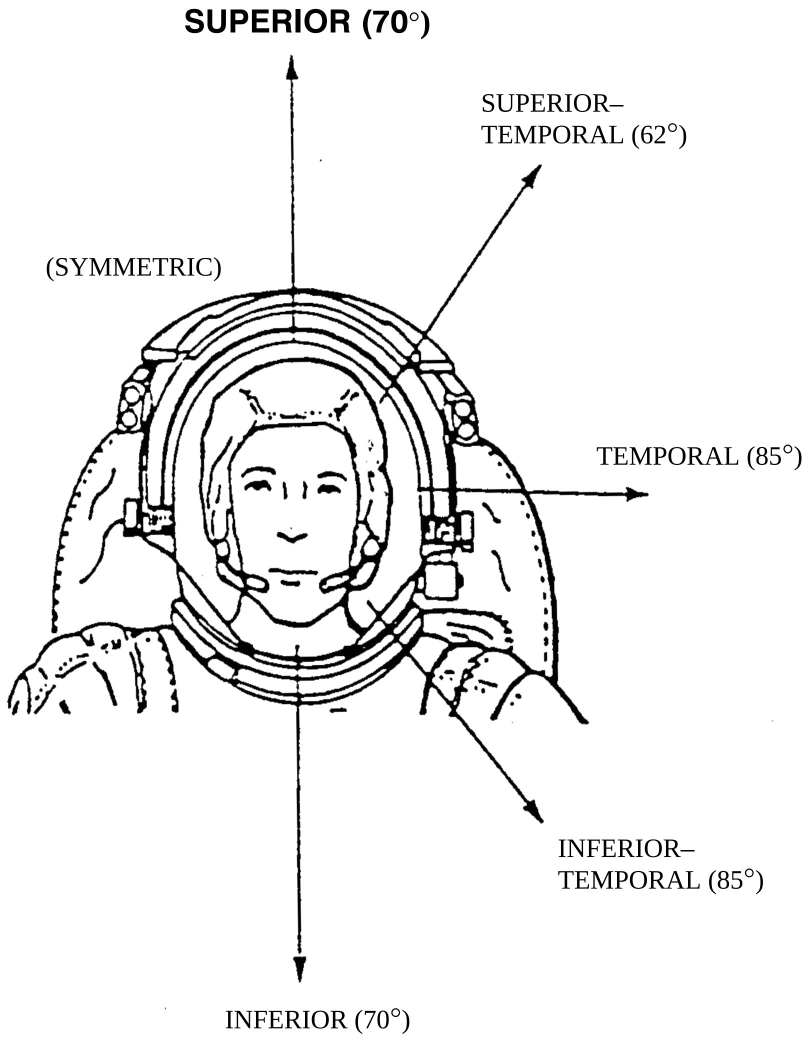


FIGURE 3.8.3.1.1.2–1 CREWMEMBER FIELD OF VIEW

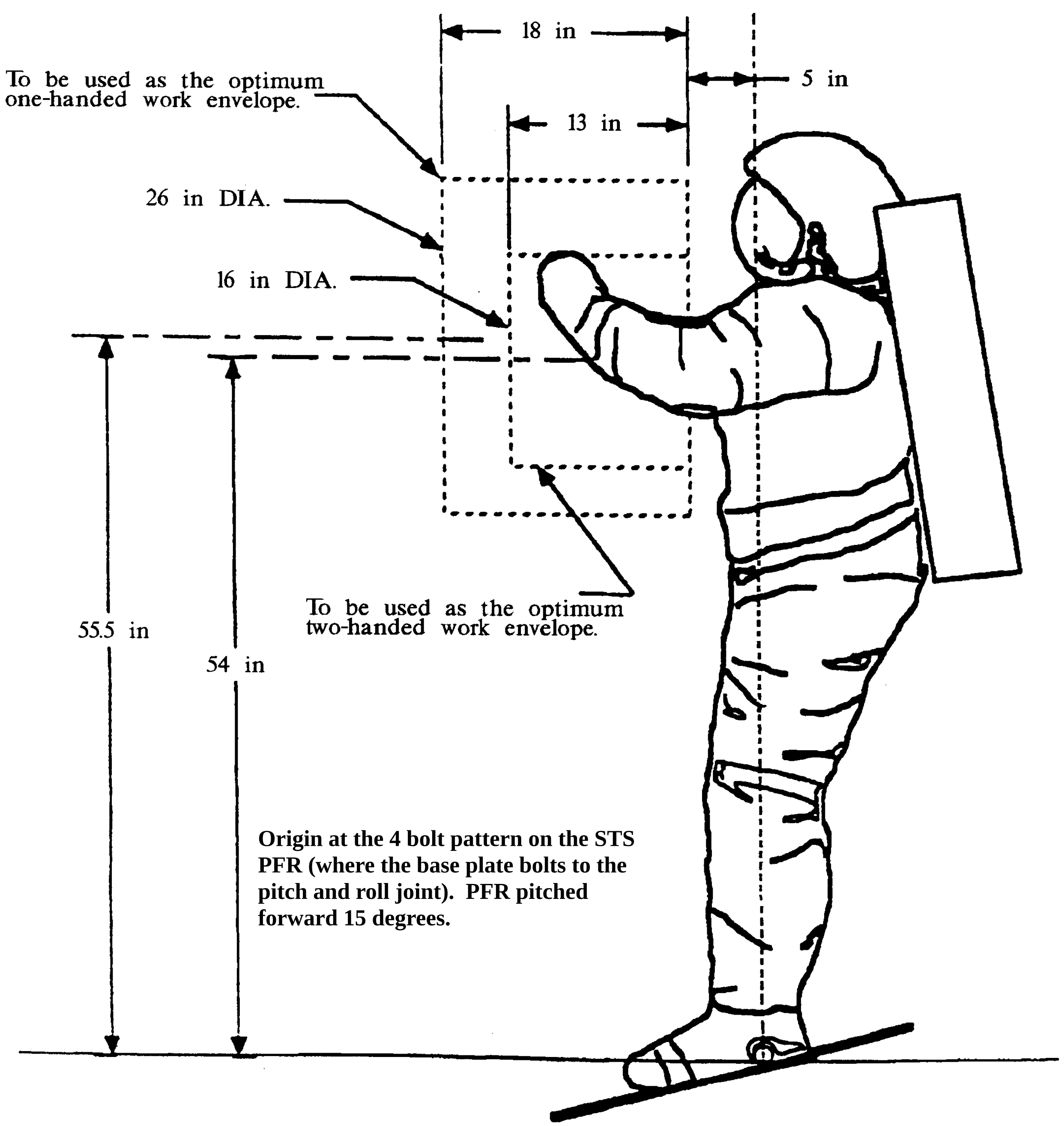
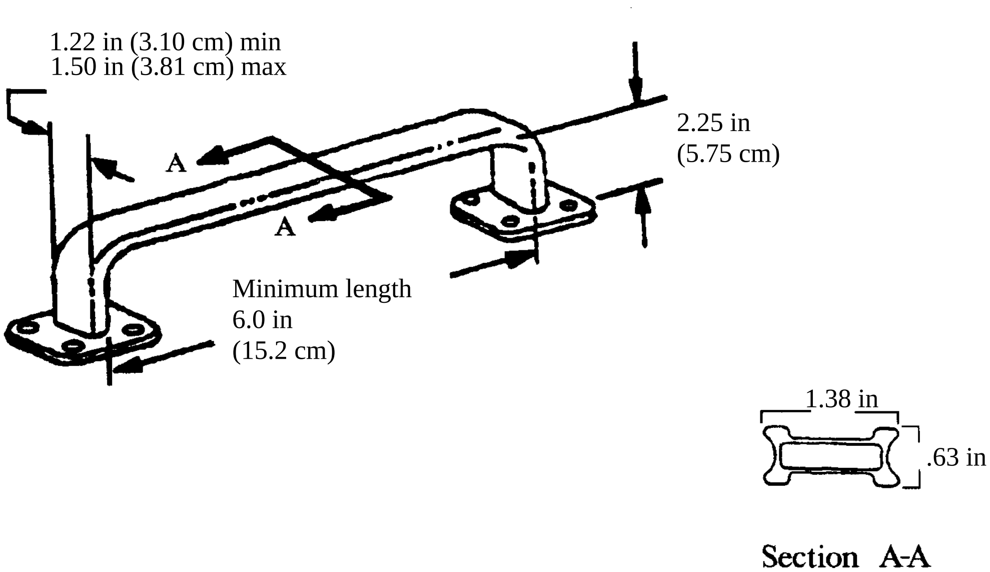


FIGURE 3.8.3.1.1.3–1 CREWMEMBER OPTIMUM WORK ENVELOPE

3.8.3.3.1.2 DIMENSIONS

EVA handhold and handrail dimensions shall conform to Figure 3.8.3.3.1.2–1.



Note: 1 – Dimensions +/– 0.060 in (0.15 cm)
2 – Tether points not shown.

FIGURE 3.8.3.3.1.2–1 STANDARD EXTRAVEHICULAR ACTIVITY HANDHOLD DIMENSIONAL REQUIREMENTS

3.8.3.3.1.3 MOUNTED CLEARANCE

A. The minimum clearance distance between the low surface of the handrail/handhold and the mounting surface shall be 2.25 in. (5.7 cm).

B. Handle and grasp areas shall be located so that they do not interfere with equipment location or maintenance.

C. EVA clearances shall be provided between handles and obstructions consistent with gloved hand sizes as given in Figure 3.8.3.4.1–1.

3.8.3.3.1.4 POSITIONING/LOCATION

A. Translation and mobility handholds shall be positioned such that crew–operated equipment is accessible and not obstructed visually or physically by the handholds.

B. Handles and grasp areas shall be placed on the accessible surface of a payload item consistent with the removal direction.

C. Mobility handholds located within 3 ft. of Attached Payload or ISS equipment which poses a critical or catastrophic hazard to the crewmember or the equipment shall be identified and color coded.

3.8.3.3.1.5 NON–FIXED HANDLES DESIGN

Hinged, foldout, or attachable (i.e., non–fixed) handles will comply with the following:

A. Nonfixed handles shall have a stop position for holding the handle perpendicular to the surface on which it is mounted.

B. Nonfixed handles shall be capable of being placed in the use position by one hand and shall be capable of being removed or stowed with one hand.

C. Attachable/removable handles shall incorporate tactile and/or visual indication of locked/unlocked status.

3.8.3.3.1.6 HANDRAIL/HANDHOLD TETHER ATTACHMENT

EVA handrails/handholds shall accommodate safety tether hooks.

3.8.3.3.1.7 DANGER WARNINGS

Translation and mobility handholds located within 3 ft. of payload equipment which poses a critical or catastrophic hazard to the crewmember or to the equipment shall be identified and color coded in accordance with EVA labeling requirements in SSP 50005.

3.8.3.3.1.8 COLOR

EVA handrails/handholds and safety tether points shall be yellow anodized.

3.8.3.3.2 EXTRAVEHICULAR ACTIVITY SAFETY TETHERS AND SAFETY HOOKS

Crew safety tether points shall be provided along all routes and at worksites.

3.8.3.3.2.1 TETHER ATTACHMENT POINTS

A. All equipment items shall be provided a standardized tether hook receptacle shown in Figure 3.8.3.3.2.1–1.

B. The standardized tether hook receptacle shall also be provided on the interfacing surface to which the item is to be secured.

C. The EVA handrail/hold tether point shall be designed as shown in Figure 3.8.3.3.2.1–2.

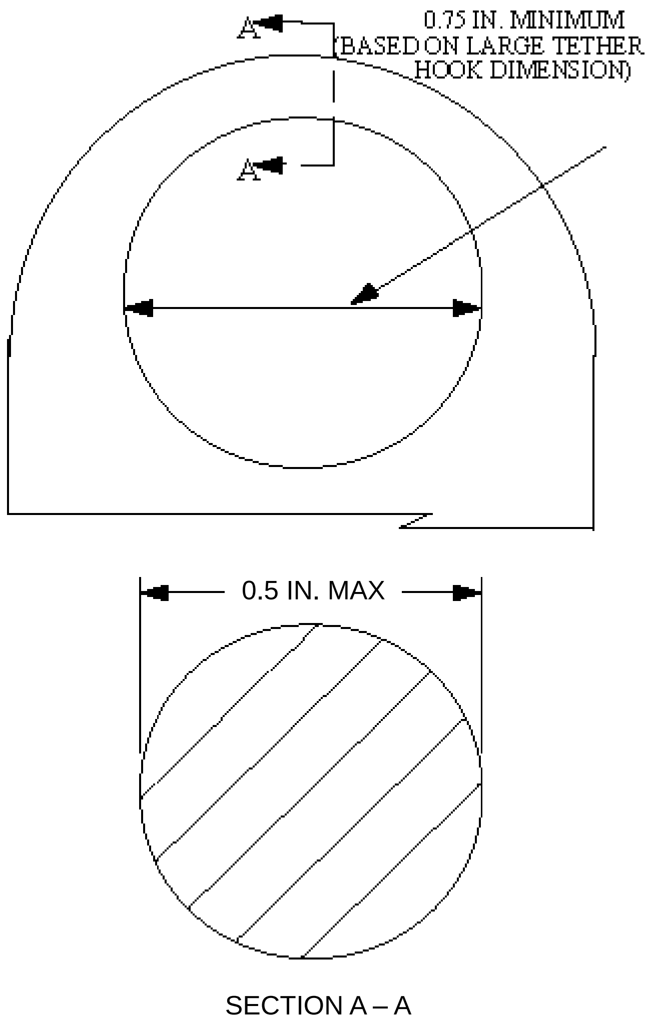


FIGURE 3.8.3.3.2.1–1 EXTRAVEHICULAR ACTIVITY EQUIPMENT TETHER ATTACHMENT POINTS

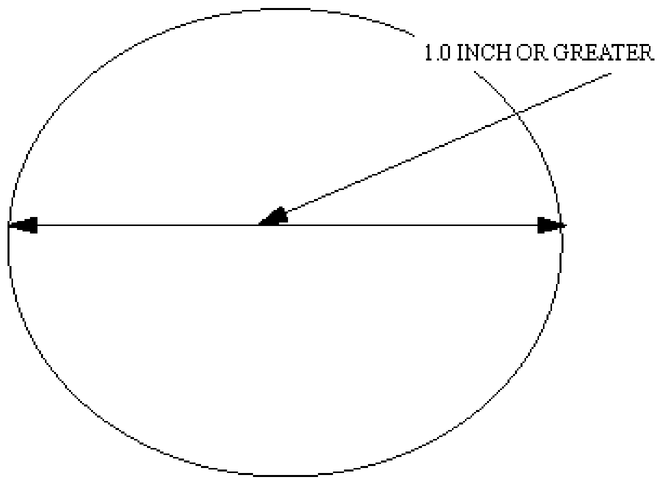


FIGURE 3.8.3.3.2.1–2 EXTRAVEHICULAR ACTIVITY HANDRAIL/HOLD TETHER POINT

3.8.3.4 GLOVED OPERATION

3.8.3.4.1 EXTRAVEHICULAR ACTIVITY GLOVED HAND ACCESS

Attached Payload equipment and structures requiring EVA interfaces shall be designed to maintain a minimum clearance envelope of 8 in (20 cm) high by 10.5 in by (27 cm) wide with maximum depth of 18 in (46 cm) for gloved access as shown in Figure 3.8.3.4.1–1.

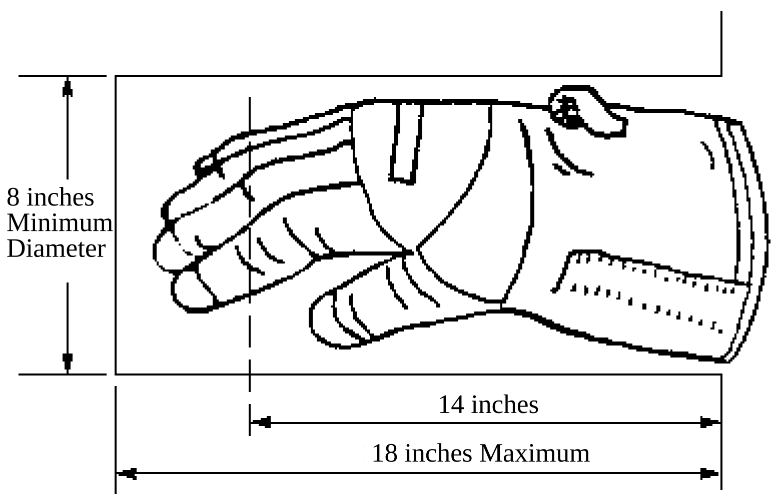


FIGURE 3.8.3.4.1–1 WORK ENVELOPE FOR GLOVED HAND

3.8.3.5 LOCATION CODING

The Attached Payload shall have a single consistent alphanumeric operational coding standard for designating locations across the entire ISS in accordance with SSP 30575, Interior and Exterior Operational Location Coding System, paragraph 4.1.

3.8.4 HUMAN ENGINEERING SAFETY

3.8.4.1 EXTERNAL TOUCH TEMPERATURE

3.8.4.1.1 INCIDENTAL CONTACT

For incidental contact, temperatures shall be maintained within –180 to +235 degrees F or limit heat transfer rates as specified in Table 3.8.4.1.1–1.

TABLE 3.8.4.1.1–1 HEAT TRANSFER RATES

Object Temperature	Contact Duration (minutes)	Boundary Node Temperature (degrees Fahrenheit)	Linear conductor (BTU/hour degrees Fahrenheit)	Maximum Average Heat Rate (1) (BTU/hour)
Hot Object	Unlimited Incidental (0.5 max)	113 113	1.149 1.444	42.52 (2) 176.2 (3)
Cold Object	Unlimited Incidental (0.5 max)	– 40 – 40	1.062 1.478	±132.7 (2) ±325.2 (3)

Notes:

(1) Positive denotes heat out of the object, negative denotes heat into the object.

(2) Averaged over 30 minutes of simulated contact (excursions up to 1.5 times this rate for 3 minute intervals are allowable).

(3) Averaged over 2 minutes of simulated contact (excursions up to 2.5 times this rate for 12 second intervals are allowable).

3.8.4.1.2 UNLIMITED CONTACT

For unlimited contact, temperatures shall be maintained within –45 to +145 degrees F, or for designated EVA crew interfaces specified in Table 3.8.4.1.2–1, limit heat transfer rates as specified in Table 3.8.4.1.1–1.

TABLE 3.8.4.1.2–1 DESIGNATED EXTRAVEHICULAR ACTIVITY INTERFACES

EVA tools and support equipment
EVA translation aids (e.g., handrails, handholds, etc.)
EVA restraints (foot restraints, tethers, tether points, etc.)
All EVA translation paths (handrails or structure identified for use as a translation path)
All surfaces identified for operating, handling, transfer, or manipulation of hardware
EVA stowage
EVA worksite accommodations (handholds, APFR ingress aids, EVA lights, etc.)
EVA ORU handling and transfer equipment

3.8.4.2 EQUIPMENT CLEARANCE FOR ENTRAPMENT HAZARDS

Clearance shall be provided for equipment removal and replacement to prevent the creation of a crew entrapment hazard.

3.8.4.2.1 EXTERNAL CORNER AND EDGE PROTECTION

3.8.4.2.1.1 SHARP EDGES

Attached Payload equipment and structures along translation routes, worksite provisions, and each equipment item requiring an EVA interface shall protect the crew from injury due to sharp edges by the use of corner and edge guards or by rounding the corners and edges in accordance with NSTS 07700, Volume XIV, Appendix 7, paragraph 2.3.

3.8.4.2.1.1.1 EXPOSED EDGE REQUIREMENTS

A. Exposed edges .25 in (6.4 mm) thick or greater shall be rounded to minimum radius of 3.0 mm (0.12 in.). See Figure 3.8.4.2.1.1.1–1.

B. Exposed edges 0.12 to 0.25 in. (3.0 to 6.4 mm) thick shall be rounded to a minimum radius of 0.06 in. (1.5 mm). See Figure 3.8.4.2.1.1.1–2.

C. Exposed edges 0.02 to 0.12 in (0.5 to 3.0 mm) thick shall be rounded to a full radius. See Figure 3.8.4.2.1.1.1–3.

D. The edges of thin sheets less than 0.02 in. (0.5 mm) thick shall be rolled or curled. See Figure 3.8.4.2.1.1.1–4.

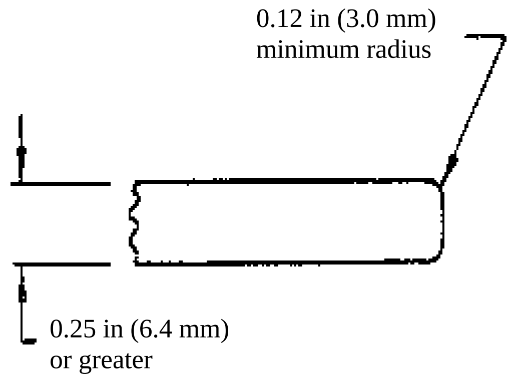


FIGURE 3.8.4.2.1.1.1–1 REQUIREMENTS FOR ROUNDING EXPOSED EDGES 0.25 IN. (6.4 MM) THICK OR THICKER

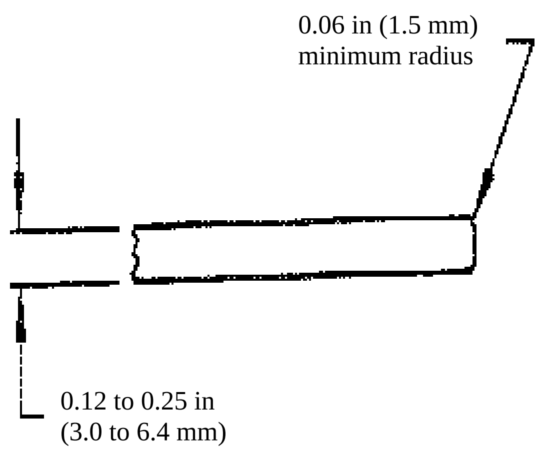


FIGURE 3.8.4.2.1.1.1–2 REQUIREMENTS FOR ROUNDING EXPOSED EDGES 0.12 TO 0.25 IN. (3.0 TO 6.4 MM) THICK

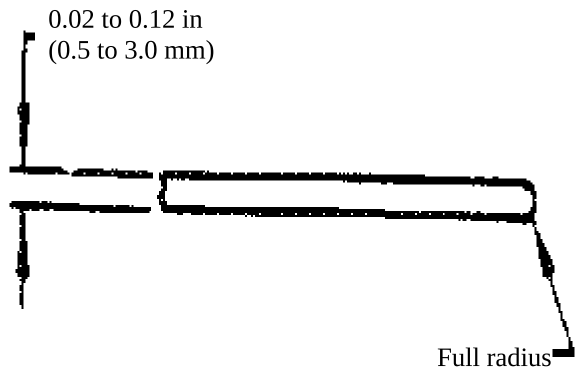


FIGURE 3.8.4.2.1.1.1–3 REQUIREMENTS FOR ROUNDING EXPOSED EDGES 0.02 TO 0.12 IN. (0.5 TO 3.0 MM) THICK

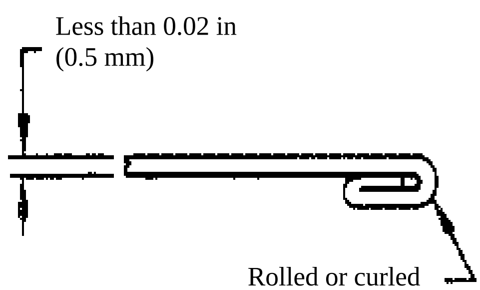


FIGURE 3.8.4.2.1.1.1–4 REQUIREMENTS FOR CURLING OF SHEETS LESS THAN 0.02 IN. (0.5 MM) THICK

3.8.4.2.1.1.2 EXPOSED CORNER REQUIREMENTS

A. Exposed corners of materials less than 1.0 in. (25 mm) thick shall be rounded to a minimum radius of 0.5 in (13 mm). See Figure 3.8.4.2.1.1.2–1

B. Exposed corners of materials that exceed 1.0 in. (25 mm) thick shall be rounded to 0.5 in (13 mm). See Figure 3.8.4.2.1.1.2–2

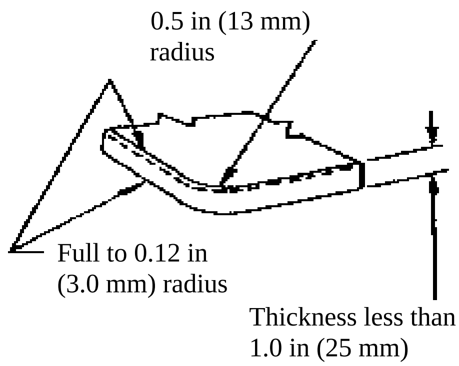


FIGURE 3.8.4.2.1.1.2–1 REQUIREMENTS FOR ROUNDING OF CORNERS LESS THAN 1.0 IN. (25 MM) THICK

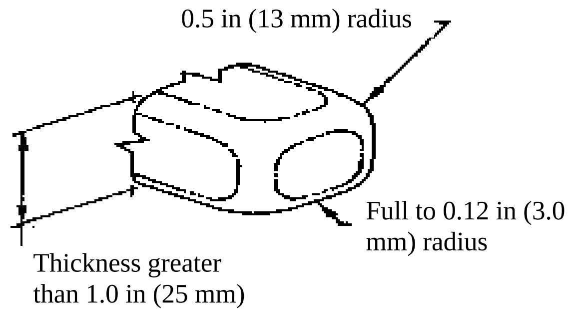


FIGURE 3.8.4.2.1.1.2–2 REQUIREMENTS FOR ROUNDING OF CORNERS GREATER THAN 1.0 IN. (25 MM) THICK

3.8.4.2.1.2 THIN MATERIALS

Materials less than 0.08 inch thick with exposed edges that are uniformly spaced, not to exceed 0.5 inch gaps, flush at the exposed surface plane and shielded from direct EVA interaction, shall have edge radii greater than 0.003 inches.

3.8.4.2.2 BURRS

Exposed surfaces shall be smooth and free of burrs.

3.8.4.2.3 HOLES

Holes that are round or slotted in the range of 0.4 to 1.0 in. (10.0 to 25.0 mm) shall be covered.

3.8.4.2.3.1 HANDRAILS/HOLDS

Holes (round, slotted, polygonal) in EVA translation handrails/holds shall be 1.0 in. or greater in diameter.

3.8.4.2.4 PINCH POINTS

External EVA actuated equipment which pivots, retracts, or flexes such that a gap of greater than 0.5 inches but less than 1.4 inches exists between the equipment, in its deployed configuration, and adjacent structure shall be designed to prevent entrapment of EVA crewmember appendages.

3.8.4.2.5 PROTECTIVE COVERS FOR PORTABLE EQUIPMENT

Portable equipment which does not meet the corner and edge requirements shall be covered or shielded when not in use.

3.8.4.2.6 LATCHES

3.8.4.2.6.1 DESIGN

A. Latches or similar devices shall be designed to prevent entrapment of crewmember appendages.

B. Latches that pivot, retract, or flex so that a gap of less than 1.4 in. (35 mm) exists shall be designed to prevent entrapment of a crew member’s appendage.

C. Over–center latches shall include a provision to prevent undesired latch element realignment, interference, or reengagement.

D. Latch catches shall have locking features.

E. If the latch has a handle, the latch handle and latch release shall be operable by one hand.

3.8.4.2.6.2 PROTECTIVE COVERS OR GUARDS

Latches or similar devices in the proximity of crewmember translation paths and maintenance worksites shall utilize a protective guard or cover to protect against a snag or inadvertent opening by a crewmember.

3.8.4.2.7 CAPTIVE PARTS

Payloads and payload equipment shall be designed in such a manner to ensure that all unrestrained parts (e.g., knobs, handles, lens covers, access plates, or similar devices) that may be temporarily removed on orbit will be tethered or otherwise held captive.

3.8.4.2.7.1 SCREWS AND BOLTS

Screws or bolts, except internal ORU screws and bolts, in established worksites (planned and planned contingency) and translation route corridors with exposed threads protruding greater than 0.12 inch shall have protective features (caps) that do not prevent installation or removal of the fastener but do protect against sharp threads.

3.8.4.2.7.2 SECURING PINS

Securing pins in hand rails shall be designed to prevent their inadvertently backing out above the handhold surface.

3.8.4.2.7.3 LOCKING WIRES

No Attached Payload maintenance equipment installations or operational interfaces shall be lockwired or staked.

3.8.4.2.8 SAFETY CRITICAL FASTENERS

Safety critical fasteners shall be designed to prevent inadvertent back out.

3.8.4.2.9 LEVERS, CRANKS, HOOKS, AND CONTROLS

Levers, cranks, hooks, and controls shall be located such that they cannot pinch, snag, cut, or abrade the crewmembers or their clothing (i.e., EVA suit).

3.8.4.3 MOVING OR ROTATING EQUIPMENT

The EVA crewmember shall be protected from moving or rotating equipment.

3.8.4.4 POWER SOURCES

Design of any nuclear reactor power source or radioisotopic generator power source located on an Attached Payload shall protect crewmembers from radiation exposure.

3.8.4.5 TRANSMITTERS

Attached Payload with high power electromagnetic wave transmitters shall protect crewmembers from harmful exposure to non–ionizing radiation. In the event of EVA proximity operations near an Attached Payload with high power electromagnetic wave transmitters, Attached Payloads shall implement safing procedures to temporarily inhibit high power electromagnetic wave transmitters from operating during the duration of the EVA proximity operations.

3.9 MAINTAINABILITY AND MAINTENANCE

3.9.1 QUALITATIVE MAINTAINABILITY DESIGN

Attached Payload facility hardware and software may be designed to be maintainable to allow functions to be reinstated or restored throughout its intended operational life. Attached Payloads which are not designed for planned maintenance are not required to meet the requirements of this section and 3.9.2. All Attached Payloads must adhere to the requirements of section 3.8.

3.9.1.1 FAILURE DETECTION, ISOLATION, AND RECOVERY

3.9.1.1.1 MANUAL FAILURE DETECTION, ISOLATION, AND RECOVERY

The following categories of functions/equipment shall utilize crew interaction or crew observation for manual failure detection, isolation, annunciation, and recovery:

A. Human/equipment interfaces such as visual display devices, cursor control devices, and manual input devices shall be in accordance with SSP 50005, paragraph 12.3.2.1.

B. General and specialized lighting.

C. Audible caution and warning devices such as warning panel lamps/lights.

D. Structural, mechanical, electromechanical, and electrical equipment that have no interconnection for data collection and transmission to the core computational data network (The intent is not to require special instrumentation for fluid, power and data lines, structure and manually operated equipment)

E. One time use equipment that has manual redundancy (crew intervention upon failure of automatic function) and is not intended to be maintained on–orbit during the life of the program such as bolt motor controllers for assembly operations.

3.9.1.2 RESERVE

3.9.1.3 ACCESS

A. Payload hardware shall be geometrically arranged to provide physical and visual access for all payload installation, operations, and maintenance tasks.

B. Access to inspect or replace an item (i.e., a payload remove/replace item) shall not require removal of another ORU or more than one access cover.

C. Attached Payload shall provide EVA access for Attached Payload remove and replace items in accordance with SSP 50005, paragraphs 14.3.2.3.1 and 14.4.3.

D. Equipment to which rear access is required shall be free to open or rotate to its full distance and remain in the “open” position without being supported by hand.

3.9.1.4 NONPRESSURIZED AREA EQUIPMENT MAINTENANCE TIME

A. Attached Payload equipment shall be designed such that maintenance tasks can be divided into subtasks that can be completed in a single EVA sortie of less than 3 hours.

B. Worksite maintenance tasks exceeding 3 hours shall be partitioned and safed into subtasks, of less than 3 hours, so that the task can be resumed on a succeeding EVA.

3.9.1.5 ACCESS ITEM RETAINMENT

The Attached Payload shall provide a means (i.e., hinges, tethers, etc.) to retain access covers, caps, and other structural parts that require on–orbit maintenance or other planned activities clear of the worksite working volume in accordance with SSP 50005, paragraph 12.3.1.2.

3.9.1.5.1 CAPTIVE PARTS

Payloads and payload equipment shall be designed in such a manner to ensure that all unrestrained parts (i.e., knobs, handles, covers, access plates, or similar devices) that may be temporarily removed on orbit will be tethered or otherwise held captive.

3.9.1.6 INSTALLATION/REMOVAL

3.9.1.6.1 METHOD

All replaceable items (payload remove/replace or maintenance items) shall be removable with the gloved hand alone or with common hand tools found in the EVA generic tool list in SSP 30256:001, Tables 3.2–1 and 3.2–2.

3.9.1.6.2 EQUIPMENT ITEM INTERCONNECTING DEVICES

The Attached Payload shall provide utility line attachment/mounting length to allow removal/replacement of the equipment item.

3.9.1.6.3 INCORRECT EQUIPMENT INSTALLATION

The Attached Payload remove/replace items shall contain physical provisions (a structural or mechanical barrier) to preclude incorrect installation of equipment.

3.9.1.6.4 LOCKWIRING AND STAKING

No Attached Payload planned maintenance equipment installations or operational interfaces shall be lockwired or staked.

3.9.1.6.5 RESTRAINING AND HANDLING DEVICES FOR TEMPORARY STORAGE

A. Attached Payload external equipment shall allow for restraining and handling by EVA crew to provide temporary storage.

B. Attached Payload external equipment that uses robotic devices for planned maintenance shall also allow for the restraining and handling by the robotic devices to provide temporary storage.

3.9.1.6.6 INSTALLATION/REMOVAL FORCE

Hardware mounted into a capture–type receptacle that requires a push–pull action shall require a force less than 35 lbf (156 N) to install or remove.

3.9.1.6.6.1 DIRECTION OF REMOVAL

Replaceable items (remove/replace or maintenance items) shall be removable along a straight path until they have cleared the surrounding structure.

3.9.1.6.6.2 VISIBILITY

All forward edges of the equipment item shall be visible to the restrained crewmember during alignment and attachment.

3.9.1.6.6.3 MOUNTING ALIGNMENT

A. Equipment items shall be designed, labeled, or marked to facilitate proper installation.

B. When alignment marks are used, they shall be applied to both mating parts

   (1) The marks shall align when parts are in the installation position.

   (2) The marks shall consist of a straight or curved line of a width and length to allow accurate alignment.

C. All electrical connectors shall have provisions for alignment and mating of connector shells prior to electrical path completion.

3.9.1.6.7 ORBITAL REPLACEABLE UNIT

3.9.1.6.7.1 CAPTURE LATCH ASSEMBLY AND UMBILICAL MECHANICAL ASSEMBLY EVA OVERRIDE

Attached Payload shall provide EVA access for CLA and UMA override.

3.9.1.6.7.2 PAYLOAD ATTACH SYSTEM AND UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM ORBITAL REPLACEMENT UNIT EXTRAVEHICULAR ACTIVITY MAINTENANCE

Attached Payload shall provide EVA access for PAS and UCCAS ORU (CLA, UMA and guide vane) maintenance per SSP 50005, paragraphs 14.3.2.3.1 and 14.4.3.

3.9.1.6.7.3 ATTACHED PAYLOAD REMOVE/REPLACE ITEMS

Remove/replace items designed for dexterous robotic manipulation shall also be maintainable by EVA.

3.9.1.7 STANDARD EXTRAVEHICULAR ACTIVITY/EXTRAVEHICULAR ROBOTICS INTERFACES

A. Hardware located in nonpressurized areas to be manipulated by EVA shall be in accordance with SSP 30256:001, paragraph 3.1.

B. Hardware located in nonpressurized areas to be manipulated by EVR systems shall be in accordance with SSP 42004, sections A3, B3, C3, D3, E3, and I3, as applicable.

3.9.1.7.1 EXTRAVEHICULAR ACTIVITY TOOLS

Attached Payload equipment on–orbit inspection remove/replace and maintenance tasks requiring EVA shall utilize the tools specified in SSP 30256:001, Tables 3.2–1 and 3.2–2.

3.9.1.7.1.1 TOOL CLEARANCE

A. Equipment and structures surrounding bolts requiring EVA ratcheting shall protect a 90 degree throw angle and shall allow right or left handed operations.

B. Structure surrounding tool actuated fasteners shall provide 3 in. clearance for EVA gloved–hand access around the tool handle for the sweep of the handle as shown in Figure 3.9.1.7.1.1–1.

C. Equipment and structure surrounding EVA tool actuated fasteners shall provide EVA tool head clearance as defined in Figure 3.9.1.7.1.1–1, except when fasteners are released using a robotic interface.

3.9.1.7.2 PAYLOAD HARDWARE AND EQUIPMENT MOUNTING

A. Attached Payload hardware shall be designed, labeled, or marked to prevent improper installation.

B. Alignment marks that are used shall be consistent and on both mating parts.

3.9.1.7.3 CONNECTORS

Attached Payload connectors shall conform to the connector design requirements in SSP 50005, paragraph 14.6.4.3.

3.9.1.7.3.1 ONE–HANDED OPERATION

A. All connectors, whether operated by hand or tool, shall be designed so they can be mated/demated using one hand.

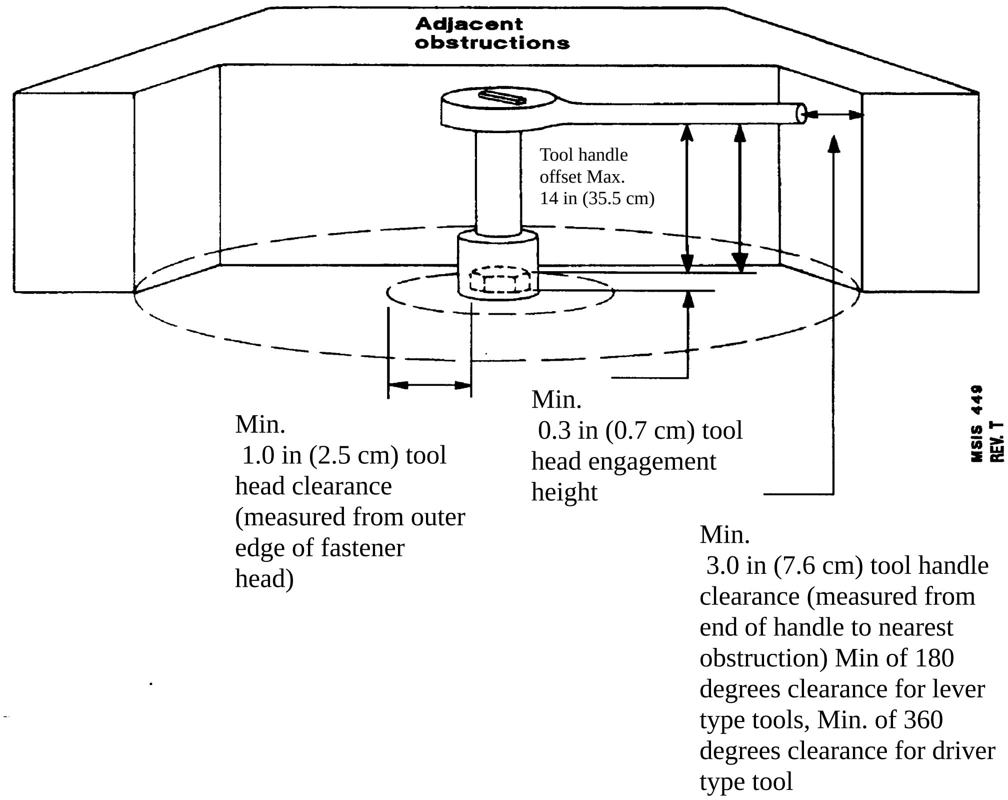


FIGURE 3.9.1.7.1.1–1 VISUAL AND HAND ACCESS FOR EXTRAVEHICULAR ACTIVITY TOOLS AND REQUIRED CLEARANCE

B. Connector design and placement shall not preclude the use of either the right or the left hand.

3.9.1.7.3.2 MATE/DEMATE

A. It shall be possible to mate/demate individual connectors without having to remove or mate/demate other connectors.

B. Electrical connectors and cable installations shall permit disconnection and reconnection without damage to wiring connectors.

3.9.1.7.3.3 CONNECTOR ARRANGEMENT

A. Space between connectors and adjacent obstructions shall be a minimum of 1.6 inches for EVA access.

B. Connectors in a single row or staggered rows which are removed sequentially by the crew shall provide 1.6 inches of clearance from other connectors and/or adjacent obstructions for 270 degrees of sweep around each connector beginning at the start of a removal/ replacement sequence.

3.9.1.7.3.3.1 STATUS

Methods shall be provided to indicate connector mating status.

3.9.1.7.3.4 CONNECTOR PROTECTION

Protection shall be provided for all demated connectors against physical damage and contamination.

3.9.1.7.3.4.1 PROTECTING CAPS

All connector protective caps shall be tethered.

3.9.1.7.3.5 CODING

A. Both halves of mating connectors shall display a code or identifier which is unique to that connection.

B. The labels or codes on connectors shall be located so they are visible when connected or disconnected.

3.9.1.7.3.6 PIN IDENTIFICATION

Each pin shall be identified in each electrical plug and each electrical receptacle.

3.9.1.7.3.7 ORIENTATION

Grouped plugs and receptacles shall be oriented so that the aligning pins or equivalent devices are in the same relative position.

3.9.1.7.3.7.1 SPACING

A. Attached Payload connector spacing shall be in accordance with SSP 50005, paragraph 11.10.3.6.

B. Where wing connectors are used, the minimum clearance between adjacent wing tabs shall be 2.5 inches.

3.9.1.7.4 CABLE RESTRAINTS

A. The loose ends of cables shall be restrained.

B. Cables with connectors that may be mated/demated on orbit shall be restrained at the ends by EVA compatible clamps to facilitate EVA maintenance operations.

C. Cables, conductors, or bundles shall be secured by means of clamps unless they are contained in wiring ducts or cable retractors.

D. Cables shall be bundled if multiple cables are running in the same direction.

3.9.1.7.5 COVERS

A. An access cover shall be provided whenever routine maintenance operations would otherwise require removing the entire case or cover, or dismantling an item of equipment.

B. Closures shall be removable to allow maintenance of equipment.

C. Closures shall have a positive means of indicating that they are locked.

D. Non–structural closures shall be capable of sustaining EVA–induced loads as specified in Table 3.1.1.2.6–1.

E. Bulkheads, brackets, and other units shall not interfere with removal or opening of covers.

F. All access covers that are not completely removable shall be self–supporting in the open position.

G. Equipment housings (i.e., electrical bays) shall be designed to provide closures and covers for inaccessible areas.

H. The inaccessible areas shall be sealed to prevent any loose item from drifting into them.

3.9.1.7.6 FASTENERS

Attached Payload fasteners shall conform to the fastener design requirements in SSP 50005, paragraph 11.9.3 and 14.6.3.3.

3.9.1.7.6.1 ENGAGEMENT STATUS INDICATION

A. EVA actuated fasteners/devices shall be visually accessible to ensure proper seating or restraint in stowed or installed locations.

B. An indication of correct engagement of fasteners shall be provided.

3.9.1.7.6.2 ONE–HANDED ACTUATION

All fasteners shall allow actuation by one hand. Fasteners design and replacement shall not preclude the use of either the right or the left hand.

3.9.1.7.6.3 FASTENER CLEARANCES

A. A minimum of 3.0 in. shall be provided for clearance between a tool handle engaged on a fastener or drive stud and the nearest piece of hardware. The tool handle should be able to maintain this clearance through a full 180° swept envelope. For a driver–type tool, clearance shall be maintained through 360°.

B. EVA fasteners shall be separated to provide hand and tool clearance in accordance with SSP 50005, Figure 14.6.2.3.

C. When EVA fasteners are recessed in a robotic interface the clearance between the fastener and the robotic interface shall allow insertion, actuation, and removal of the drive end of a standard tool.

3.9.1.7.6.4 FASTENER ACCESS HOLES

Covers or shields through which mounting fasteners must pass for attachment to the basic chassis of the unit shall have holes for passage of the fastener without precise alignment (and hand or necessary tool if either is required to replace).

3.9.1.7.6.5 CAPTIVE FASTENERS

A. External fasteners shall be captive or shall have special provisions to restrain the fasteners.

B. External hardware shall preclude the use of temporary fasteners.

3.9.1.7.6.6 QUICK RELEASE FASTENERS

A. Quick release fasteners shall require a maximum of one complete turn to operate (quarter – turn fasteners are preferred).

B. Quick release fasteners shall be positive locking in open and closed positions.

3.9.1.7.6.7 OVER CENTER LATCHES

A. Over center latches shall include a provision to prevent undesired latch element realignment, interface, or reengagement.

B. Latch catches shall have locking features.

C. If the latch has a handle, the latch handle and latch release shall be operable by one hand.

3.9.1.7.6.8 FASTENER HEADS AND KNOBS

A. Fasteners and knobs for suited gloved hand operation shall have a minimum head diameter of 1.5 inches and a maximum diameter of 2 inches.

B. Fasteners and knobs shall have a minimum head height of .75 inches.

3.9.1.7.6.9 CONTINGENCY OVERRIDE

A. All EVA hand actuated rotational fasteners shall be provided with a standard–sized internal or external hexagonal feature for contingency override with a hand tool.

B. Cotter keys shall not be used by EVA.

3.9.1.7.7 CONTROLS AND DISPLAYS

3.9.1.7.7.1 CONTINGENCY EXTRAVEHICULAR ACTIVITY CONTROLS

Attached Payload EVA controls design shall conform to the requirements of SSP 50005, paragraph 9.2 and 9.3, with the following additions:

A. EVA actuated switches shall provide tactile and/or visual indication of position.

B. EVA controls shall be protected from inadvertent actuation.

3.9.1.7.7.2 DISPLAYS

A. Attached Payload EVA display types and locations shall conform to the requirements of SSP 50005, paragraphs 9.2 and 9.4.

B. EVA displays shall be located within the field of view permitted by the EMU as defined in paragraph 3.8.3.1.1.2.

3.9.1.7.7.3 LABELING

Attached Payload labeling and color coding at EVA worksites and translation paths shall meet the requirements listed in Appendix C.

3.9.2 MAINTENANCE

3.9.2.1 PLANNED MAINTENANCE OR STORAGE

Equipment that will go into a pressurized volume for planned maintenance or storage shall meet the requirements as specified in SSP 50005, paragraphs 6.3.3.1, 6.3.3.2, 6.3.3.3, and 6.3.3.11.

3.9.2.2 ON–ORBIT MAINTENANCE

A. Personnel and equipment mobility aids and restraints shall be provided to support on orbit maintenance.

B. The Attached Payload shall be externally maintained utilizing the EVA tools listed in SSP 30256:001, Table 3.2–1, for scheduled tasks and in Table 3.2–2 for unscheduled tasks.

3.9.2.2.1 CORRECTIVE MAINTENANCE

On–orbit Attached Payload corrective maintenance shall be performed by removal and replacement of payload equipment.

3.9.2.2.2 IN SITU MAINTENANCE

When on–orbit removal and replacement of payload equipment is not applicable, end item functionality shall be restored by in situ maintenance.

3.9.2.2.3 ORBITAL REPLACEMENT UNIT INTERMEDIATE MAINTENANCE

End item ORUs designated for on–orbit intermediate maintenance shall be packaged for the removal and replacement of Shop Replaceable Units (SRUs) and for other approved off equipment repairs.

3.9.2.2.4 PREVENTIVE MAINTENANCE

Preventive maintenance shall be permitted to retain end item functionality.

3.9.2.2.5 ON–ORBIT MAINTENANCE BACK–UP

Attached Payload equipment that will be removed and replaced by robotics shall have back–up EVA remove and replace capability.

3.9.2.2.6 ACCESS FOR ON–ORBIT MAINTENANCE

The Attached Payload shall provide access to all locations requiring on–orbit maintenance as specified in SSP 50005, paragraphs 14.6.2.3.A, 14.6.2.3.C, and 14.6.2.3.G.

3.9.2.2.6.1 EXTRAVEHICULAR ACTIVITY ACCESS TO FASTENERS

When EVA fasteners are recessed in a robotic interface, the clearance between the fastener and the robotic interface shall allow for insertion, actuation, and removal of the drive end of a standard EVA tool as specified in SSP 50005, paragraph 14.6.2.3.

3.9.2.2.7 STANDARD ON–ORBIT DIAGNOSTIC EQUIPMENT

Attached Payload ORUs designated for on–orbit intermediate maintenance shall be maintained utilizing the baseline diagnostic tools listed in SSP 30256:001, Tables 3.2–1 and 3.2–2.

3.9.2.3 GROUND MAINTENANCE

End item ORUs designated for repair shall be ground repairable.

3.10 NAMEPLATES AND PRODUCT MARKING

A. Attached Payload elements, loose equipment, consumables, payload remove/replace items, crew accessible connectors and cables, switches, indicators, and controls shall be labeled. Labels are markings of any form (including IMS bar codes) such as decals and placards, which can be adhered, ”silk screened”, engraved, or otherwise applied directly onto the hardware. Appendix C provides instructions for label and decal design and approval.

B. Marking techniques shall not degrade the structural integrity of the equipment.

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4.0 VERIFICATION

This section contains the formal qualification requirements to verify compliance with the requirements of this document. Non–shall statements are not required to be verified for compliance. Statements in this document utilizing the word ”shall” shall be verified.

Overall Verification Rules:

A. Data for the reliability analysis will be collected and recorded during verification.

B. Engineering (development) evaluation and tests may be required for analyzing design approaches to ensure that requirements encompassing material selection, tolerances, and operational characteristics are satisfied. If development test data is intended to be used to qualify hardware, its intent shall be predeclared.

C. Verification represents the broadest scope of assuring an Attached Payload is within design tolerances to which an Attached Payload is subjected. It encompasses the entire range of activity to verify that the design conforms to requirements when subjected to environmental lifecycle conditions. Flight–like hardware is normally used for qualification testing. Environmental models shall be used to represent environments that cannot be achieved under the conditions of ground testing. Simulators, used for verifying requirements, require independent validation so that the item undergoing verification can not distinguish between the simulator and actual operational hardware/software.

D. Integration testing and checkout shall be conducted during Attached Payload buildup. Activities such as continuity checking and interface mating shall be performed at that time. Activities such as major component operation in the installed environment, support equipment compatibility, and documentation verification will be verified during verification.

E. Formal verification of performance characteristics occurs for the full range of performance requirements during verification and for nominal operational and critical physical requirements during acceptance.

F. Hardware shall be inspected and certified that design drawings, waivers, engineering Change Requests, etc. reflect the as–built hardware.

4.1 GENERAL

Compliance with the requirements stated in Section 3 shall be proven using one or more of the following methods:

Inspection (I). Inspection is a method that determines conformance to requirements by the review of drawings, data or by visual examination of the item using standard quality control methods, without the use of special laboratory procedures.

Analysis (A). Analysis is a process used in lieu of, or in addition to, other verification methods to ensure compliance to specification requirements. The selected techniques may include, but not be limited to, engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and analog modeling. Analysis may also include assessing the results of lower level qualification activity to verify a higher level requirement.

Similarity analysis is also a valid verification method. Verification by Similarity is the process of analyzing the specification criteria for hardware configuration and application for an article to determine if it is similar or identical in design, manufacturing process, and quality control to an existing article that has previously been qualified to equivalent or more stringent specification criteria. Special effort will be made to avoid duplication of previous tests from this or similar programs. If the previous application is considered to be similar, but not equal to or greater in severity, additional qualification tests shall concentrate on the areas of new or increased requirements.

Demonstration (D). Demonstration consists of a qualitative determination of the properties of a test article. This qualitative determination is made through observation, with or without special test equipment or instrumentation, which verifies characteristics such as human engineering features, services, access features, and transportability. Demonstration requirements are normally implemented within a test plan, operations plan, or test procedures.

Test (T). Test is a method in which technical means, such as the use of special equipment, instrumentation, simulation techniques, and the application of established principles and procedures, are used for the evaluation of components, subsystems, and systems to determine compliance with requirements. Test shall be selected as the primary method when analytical techniques do not produce adequate results; failure modes exist which could compromise personnel safety, adversely affect flight systems or payload operation, or result in a loss of mission objectives; or for any components directly associated with ISS and Orbiter interfaces. The analysis of data derived from tests is an integral part of the test program, and should not be confused with analysis as defined above. Tests shall be used to determine quantitative compliance to requirements and produce quantitative results.

4.1.1 RESPONSIBILITY FOR VERIFICATIONS

Unless otherwise specified in the Payload Integration Agreement (PIA), the Attached Payload developer is responsible for the performance of verification activities as specified herein and responsible for providing all data/test results required in this paragraph. Except as otherwise specified in the PIA, the Attached Payload developer may use his own or any other facility suitable for the performance of the verification activities specified herein, unless disapproved by NASA. NASA reserves the right to perform any of the verifications set forth in this specification.

4.2 ATTACHED PAYLOAD QUALITY CONFORMANCE INSPECTIONS

Demonstrations, analyses, inspections, and any additional test requirements are specified herein. Individual verification requirements do not require a stand alone verification to be performed but may be combined with satisfying other verification requirements to prevent redundancy and optimize commonality.

4.3 INTERFACE REQUIREMENTS

4.3.1 STRUCTURAL/MECHANICAL AND MICROGRAVITY INTERFACE REQUIREMENTS

NVR

4.3.1.1 GENERAL DESIGN REQUIREMENTS

Attached Payload hardware shall be inspected and certified that design drawings, exceedances, deviations, waivers, and engineering change requests reflect the as–built hardware. Verification shall be considered successful when the inspection results in certification of the design drawings, exceedances, deviations, waivers, and engineering change requests as reflecting the as–built hardware.

4.3.1.1.1 SAFETY CRITICAL STRUCTURES

4.3.1.1.1.1 FAIL SAFE, SAFE—LIFE, OR LOW—RISK FRACTURE PARTS

An analysis shall be performed using test or analysis data in accordance with SSP 52005, section 5.3.2. When it is shown that Attached Payload structural components and materials can be classified as fail—safe, safe—life, or low—risk and that the primary structure has +0.00 or positive safety margins with respect to the loads used in the component/ material analyses during ascent, on—orbit, and descent, then the verification shall be satisfied.

4.3.1.1.1.2 FRACTURE CONTROL

Verification of this requirement shall be by performance of the Non Destructive Evaluation (NDE) inspection as defined in SSP 52005, Section 7.5. The verification will be considered successful when the applicable Attached Payload level demonstration, analysis or inspection is shown to satisfy SSP 52005 requirements.

4.3.1.1.1.3 METEOROIDS AND ORBITAL DEBRIS PROTECTION REQUIREMENT FOR EXTERNAL PAYLOADS

An inspection shall be performed of the design drawings to identify any stored energy device or hardware that could create a catastrophic hazard if impacted or penetrated by a meteoroid or orbital debris. An analysis shall be performed on M/OD critical components or subcomponents to verify that the hardware meets the requirements of SSP 52005, paragraph 5.1.5. Verification shall be considered successful when the analysis shows the requirements of SSP 52005 are satisfied.

4.3.1.1.2 INTERFACE LOADS

4.3.1.1.2.1 MARGINS OF SAFETY

An inspection of the structural analysis reports shall be performed to verify that positive margins of safety exist for all Attached Payload structural components. When it is shown that Attached Payload structural components have positive margins of safety for the specified combined loads conditions, then the verification shall be satisfied.

4.3.1.1.2.2 FACTOR(S) OF SAFETY

An inspection of the structural analysis reports shall be performed to verify that the specified factors of safety have been used in the analysis of the structure. When it is shown that Attached Payload structural components have +0.00 or positive margins of safety for the specified combined loads conditions, then the verification shall be satisfied.

4.3.1.1.2.3 DESIGN LOADS

A. Analysis shall be performed to verify that the Attached Payload is designed in accordance with the loads specified in paragraph 3.1.1.2.3. The requirement shall be considered successfully verified when the structural components have been shown by test or analysis to have positive margins of safety for the design loads specified in paragraph 3.1.1.2.3 in accordance with SSP 30559, paragraph 3.2.

B. Verification shall be by analysis or analysis and test. An assessment will be performed by the ISS on–orbit loads group. The assessment may be performed by analysis or be based on test results or similarity to an analysis or test performed for a similar payload. For an integrated on–orbit analysis, an integrated space station model shall be coupled with a payload dynamic math model provided by the payload developer in accordance with D684–10019–1, paragraph 4.5. The payload model shall be test–correlated in accordance with D684–10288–01, paragraph 3.3.1. Structural loads shall be derived using ISS forcing functions applied to the coupled AP/UCC–ISS model for the planned on–orbit mission scenario. Verification shall be considered successful when the analysis or test assessment shows that the payload does not induce loads greater than those allowed in Table 3.1.1.2.3–2.

4.3.1.1.2.4 PAYLOAD BERTHING

4.3.1.1.2.4.1 GUIDE PIN CONTACT FORCES

An analysis shall be performed to verify that the Attached Payload can withstand the berthing contact forces specified. Verification shall be successful when the analysis shows the requirements in paragraph 3.1.1.2.4.1 have been met.

4.3.1.1.2.4.2 CAPTURE BAR CONTACT FORCES

An analysis shall be performed to verify that the Attached Payload can withstand the berthing contact forces specified. Verification shall be successful when the analysis shows the requirements in paragraph 3.1.1.2.4.2 have been met.

4.3.1.1.2.5 THERMAL EFFECTS

Verification of Attached Payload structure for thermal effects combined with induced static and dynamic loads shall be performed by analysis. For on orbit flight, the analysis shall impose thermally induced on orbit interface loads specified in SD77–SH–0214, Shuttle Forcing Functions and Identification System, paragraph 2.1.9 (Quasi–static Models and Deflection Data Management/Control System), mechanically induced on orbit interface loads specified in Table 3.1.1.2.3–1, and thermally induced effects defined in 3.4. The Attached Payload structure shall be considered successfully verified for thermal effects combined with static and dynamic loading when the structure and structural components have a +0.00 or positive margins of safety.

4.3.1.1.2.6 EXTRAVEHICULAR ACTIVITY ON—ORBIT INDUCED LOADS

Verification shall be by analysis. The analysis shall show that the Attached Payload is capable of reacting the loads defined in Tables 3.1.1.2.6–1 and 3.1.1.2.6–2. Verification shall be considered successful when the analysis shows that the Attached Payload is capable of withstanding the specified loads.

4.3.1.1.3 DESIGN SERVICE LIFE

A review of the structural analysis reports shall be performed to verify that the analyses are in conformance with the specified requirements for all structural components. When it is shown that Attached Payload structural components satisfy the maximum expected design life in paragraph 3.1.1.3 and have been analyzed in conformance with the requirements as specified in SSP 30559, paragraph 3.5, then the verification shall be satisfied.

4.3.1.1.4 OPERATIONAL LIFETIME

NVR

4.3.1.1.5 INTERCHANGEABILITY

An analysis shall be performed using Attached Payload design drawings to verify that the Attached Payload configuration is compatible with installation on any of the six truss attach sites. The verification shall be considered successful when analysis including maximum and minimum tolerance stackup shows that the Attached Payload is installable and capable of safe operations at any of the truss attach sites.

4.3.1.1.6 ATTACHED PAYLOAD INTERFACE DURABILITY

An analysis shall be performed using mate and demate mechanism test data, item structural data, and material and parts data to verify interface durability. The verification shall be considered successful when the analysis shows that the on orbit Attached Payload interface to ISS will perform its intended function following the number of mate and demate cycles specified in paragraph 3.1.1.6.

4.3.1.1.7 STRUCTURAL MATERIALS CRITERIA AND SELECTION

A. An inspection shall be performed of the Attached Payload structure production drawings to verify that materials have been selected which meet the criteria as specified in paragraph 3.1.1.7. Verification will be considered successful when the inspection shows that the structural material selection is in accordance with the requirements.

B. An inspection shall be performed of the Attached Payload structure production drawings to verify that materials have been selected which meet the criteria as specified in NSTS 1700.7, ISS Addendum, paragraph 208.3. Verification will be considered successful when the inspection shows that the mechanical properties are in accordance with the requirements.

4.3.1.1.8 STRUCTURAL DEGRADATION FROM MATERIAL EROSION

A review of the structural analysis reports shall be performed to verify that potential structural erosion effects have been included in the analysis of the structure. When it is shown that Attached Payload structural components have a positive margin of safety for the required combined loads conditions, as specified in SSP 30425, then the verification shall be satisfied.

4.3.1.2 STRUCTURAL/MECHANICAL INTERFACE WITH MOBILE SERVICING SYSTEM

NVR

4.3.1.2.1 STRUCTURAL DESIGN INTERFACE

An analysis shall verify that the Attached Payload's structural interface with the MCAS meets the requirements of SSP 42004. Verification shall be considered successful when the analysis shows that the requirements of SSP 42004 are met.

4.3.1.2.2 MECHANICAL DESIGN INTERFACE

Verify by inspection of the Attached Payload drawings and test with a flight–like test article that the mechanical attach points are compatible with the MCAS as specified in SSP 42004. Verification shall be considered successful when the inspection and test confirm compatibility.

4.3.1.2.3 MASS AND ENVELOPE DIMENSIONS

A. The verification shall be by test. Determine the actual weight of the Attached Payload weight by test, including any stowage items and any Attached payload provided ancillary equipment. Verification shall be considered successful when the tests show the actual mass to be no greater than the control mass specified in 3.1.2.3.

B. The verification shall be by inspection of design drawings. Verification shall be considered successful when the inspection shows that the Attached Payload on–orbit configuration translation envelope does not exceed the dimensions specified in SSP 42004, paragraph B3.2.2.1.

4.3.1.3 STRUCTURAL/MECHANICAL INTERFACE WITH THE ITS S3 PAYLOAD ATTACH SYSTEM AND INTEGRATED TRUSS SEGMENT P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

NVR

4.3.1.3.1 STRUCTURAL/MECHANICAL

4.3.1.3.1.1 PHYSICAL ENVELOPE REQUIREMENTS

4.3.1.3.1.1.1 PAYLOAD ATTACH SYSTEM/UNPRESSURIZED LOGISTICS CARRIER ATTACH SYSTEM ON–ORBIT OPERATIONAL ENVELOPE

Verification shall be by inspection of design drawings. The inspection shall show that the maximum dimensions of the Attached Payload fit within the specified envelope. Verification shall be considered successful when the inspection shows that the Attached Payload installation configuration fits within the envelope specified in paragraph 3.1.3.1.1.1.

4.3.1.3.1.1.2 INTERFACE PLANE PROTRUSION

Verification shall be by inspection of design drawings. The inspection shall show that the Attached Payload on–orbit installed configuration does not include a structural, mechanical, utility or ORU component that would extend into the PAS/UCCAS active side of the interface plane, except for a capture bar and keel trunnion. Verification shall be considered successful when the inspection shows that the Attached Payload installation does not include protrusions into the PAS/UCCAS side of the datum plane as specified in paragraph 3.1.3.1.1.2.

4.3.1.3.1.1.3 EXTRAVEHICULAR ACTIVITY/ROBOTICS OPERATIONAL ENVELOPE

A. Verification shall be by inspection of design drawings. The inspection shall show that the EVA translation corridor and accessibility is maintained between the Attached Payload and other ISS equipment. Verification shall be considered successful when the inspection shows that the Attached Payload meets the specified envelope in the unique ICD.

B. Verification shall be by inspection of design drawings. The inspection shall show that the EVR translation corridor and accessibility shall be maintained around the operational/deployed Attached Payload and other ISS operations and the installation/removal on adjacent PAS/UCCAS sites. Verification shall be considered successful when the inspection shows that the Attached Payload meets the specified envelope in 3.1.3.1.1.3B.

4.3.1.3.1.2 MASS PROPERTIES AND CENTER OF GRAVITY

4.3.1.3.1.2.1 PAYLOAD ATTACH SYSTEM COORDINATE SYSTEM ORIGIN LOCATION

Verification shall be by inspection. The inspection shall show that all analysis for the Attached Payload is in compliance with the convention established in Figure 3.1.3.1.2.1–1. Verification shall be considered successful when the inspection shows that all analysis for the Attached Payload uses the proper convention.

4.3.1.3.1.2.2 MASS AND CENTER OF GRAVITY

Determine the actual weight of the Attached Payload by analysis based on test data, including any stowage items and any PD–provided ancillary equipment. Allowable tolerance shall be + 5.0 lbs or 0.3%, whichever is greater. Determine the actual CG by analysis based on test data of the Attached Payload in three orthogonal axes. Allowable tolerance shall be ±0.25 in. in all three axes. Verification shall be by analysis. The analysis shall show the Attached Payload CG accounts for articulating and/or dynamic payload operations. Verification shall be considered to be successful when the analysis shows the requirements have been met.

4.3.1.3.1.3 ATTACHED PAYLOAD FUNDAMENTAL FREQUENCY

The Attached Payload minimum fundamental frequency shall be determined by analysis or by dynamic testing (model survey or vibration test). Analysis shall be performed using the guidelines provided in accordance with SSP 52005, Appendix C.1.2.2, and a Finite Element Model (FEM) that has been developed in accordance with SSP 52005, paragraphs 6.1.1.2, 6.1.1.3 and 7.1. Verification shall be considered successful when the analysis or test shows the Attached Payload meets the requirements of paragraph 3.1.3.1.3.

4.3.1.3.1.3.1 INTERFACE PRELOAD

Verification shall be by analysis and test. The analysis and strength test shall show that the Attached Payload hardware will withstand a maximum preload of 6430 lbs from the PAS/UCCAS capture latch. A functional test shall show that the Attached Payload hardware when mounted on a simulated CAS active half, is capable of achieving a nominal preload of 5650 lbs ±5% applied to the payload passive PAS by the CLA.

4.3.1.3.1.3.2 INTERFACE STIFFNESS

Verification shall be by test. Verification shall be considered successful when the test shows the Attached Payload interface stiffness meets the requirements of paragraphs 3.1.3.1.3.2.

4.3.1.3.2 MECHANICAL INTERFACE

NVR

4.3.1.3.2.1 EXTRAVEHICULAR ACTIVITY RELEASABLE AND REMOVABLE CAPTURE BAR

A. Verification shall be by inspection of the production drawings. Verification shall be considered successful when the inspection shows that an EVA releasable and removable capture bar is provided by the Attached Payload design and that all crew EVA interfaces associated with the operation, removal and reinstallation of the EVA releasable and removable capture bar are in accordance with SSP 30256:001.

B. Verification shall be by analysis. Verification shall be considered successful when the analysis shows that the design, location and tolerances are in accordance with SSP 57004.

C. Verification shall be by test. Verification shall be considered successful when the Attached Payload shows by test using the Active Common Attach System Simulator (ACASS) that the maximum release dimension shown in section 3.1.3.2.1 can be attained and that the bar may be subsequently removed and reinstalled.

4.3.1.3.2.2 GUIDE PINS

A. Verification shall be by test to verify that three guide pins for interfacing with the PAS/UCCAS guide vanes are provided by the Attached Payload design. Verification shall be considered successful when the test shows that the requirement of interfacing with the PAS/UCCAS guide vanes has been satisfied.

B. Verification shall be by analysis. Verification shall be considered successful when the analysis shows that the design, location and tolerances are in accordance with SSP 57004.

4.3.1.3.2.3 PASSIVE UMBILICAL MECHANISM ASSEMBLY

A. Verification shall be by analysis. Verification shall be considered successful when the analysis shows that the Attached Payload UMA configuration has provided the structural/mechanical interface to the PAS/UCCAS UMA part number 1F70162–1, or equivalent, to allow physical integration of the Attached Payload to a truss site.

B. Verification shall be by analysis. Verification shall be considered successful when the analysis shows that the Attached Payload UMA configuration is accessible for manual EVA backup operations and EVA removal in accordance with SSP 50005, paragraph 12.3.

4.3.1.3.2.3.1 PASSIVE UMA MOUNTING BRACKET

A. Verification shall be by analysis and test. Verification shall be considered successful when the analysis shows that the passive UMA is located on the payload structure as defined in SSP 57004, Figure 3.1.2.2–1 and when the test shows that the Attached Payload structurally and mechanically interfaces with the passive UMA and allows physical integration of the PAS/UCCAS UMA passive and active halves.

B. Verification shall be by analysis. Verification shall be considered successful when the analysis shows that Attached Payload passive UMA mounting bracket has been designed to the interface loads specified in 3.1.3.2.3.1.

C. Verification shall be by analysis. Verification shall be considered successful when the analysis shows that the Attached Payload UMA mounting bracket satisfies the stiffness requirement specified in Section 3.1.3.2.3.1.

D. Verification shall be by analysis. Verification shall be considered successful when the analysis shows that UMA passive half as mounted is maintained within its on–orbit operating temperature range. A passive UMA model, including thermal properties at the interface, shall be supplied by NASA.

4.3.1.3.2.4 MECHANICAL STOP DESIGN

A. Verification shall be by analysis. Verification shall be considered successful when it has been shown that the Attached Payload on orbit flight drawings and design includes mechanical stops for all gimbaled and mechanical actuating devices that have been designed with the mechanical strength necessary to absorb the maximum expected energy when contact is made using the factors of safety defined in SSP 52005.

B. Verification shall be by analysis. Verification shall be considered successful when it has been shown that the Attached Payload mechanical stops have been designed for four times the number of expected duty cycles.

4.3.1.3.2.5 SAFETY INTERLOCKS

Verification shall be by analysis. An analysis shall be performed using data from drawings, software requirements/implementation documentation, hazard analyses, and ICDs to identify hazardous operations during maintenance and the implementation of related safety interlocks. The verification shall be considered successful when it has been shown that installed interlocks provide the necessary inhibit functions for all identified hazards during maintenance.

4.3.1.3.2.6 MICROGRAVITY

NVR

4.3.1.3.2.6.1 LIMIT QUASI–STEADY ACCELERATIONS

Forces produced by a payload below 0.01 Hz shall be verified by analysis against paragraph 3.1.3.2.6.1. This analysis shall be considered successful when it is shown that no impulse is exerted by the payload to the ISS greater than 10 lbs–s (44.5 N–s) over any 10 to 500 second interval.

4.3.1.3.2.6.2 LIMIT VIBRATORY AND TRANSIENT ACCELERATIONS

4.3.1.3.2.6.2.1 VIBRATORY REQUIREMENTS

Verification of non–isolated attached payload mechanical vibration against 3.1.5.2 shall be accomplished by Finite Element Modeling (FEM), Statistical Energy Analysis (SEA), test or simplified analysis as discussed in the following paragraphs. SEA may be performed where sufficient modal density is present as defined by the SEA parameter limitations explanation included with the SEA model. FEM analysis is to be performed to the ISS side of the PAS Interface Plane using a force limit requirement of Table 3.1.5.2–1. In applying this methods, the following are to be observed:

A. Payload FEM models must use a damping factor of 0.5% unless alternative damping values are shown appropriate by test. Damping coefficient test data must be obtained using force levels no greater than the maximum disturbance force allowable to meet microgravity requirements and at the approximate location for the payload disturbance. High strain producing test methods are to be avoided since such test may increase damping, leading to misleading results.

B. The one–third octave force limits include allowance for payload frequency deviation as large as 10% from predicted or measured values. Payloads with disturbance frequency variation and uncertainty which exceeds 10% shall use worst–case assumptions for frequency disturbances close to one–third octave boundaries.

C. If multiple disturbance sources that are not phase synchronized are present , then the effect of each source operating independently is to be added in RSS fashion. If the disturbance sources are phase synchronized then the sum of the vibration contributions for each disturber in phase must be added in the appropriate source phase.

D. To ensure capture of modal peak responses in finite element frequency domain verification procedures, the transfer function and/or response analysis should explicitly include the modal frequencies of the finite element model. These should be supplemented with additional frequencies to adequately capture off–peak responses. It is required that the supplemental frequency density be sufficient to include at least one additional frequency within the half–power bandwidth of the modes. A constant logarithmic frequency spacing in which the delta frequency factor (deltafreq=deltafreqfac*lastfreq) is less than the half–power bandwidth (halfpowbw=2*c/ccrit) provides such a condition. For a damping coefficient of .5% of critical damping, this requires each sample bandwidth to be no greater than 1.01 of the sample bandwidth below. This permits logarithmic frequency spacing for analytical data and requires frequency spacing determined by the lowest frequency of concern for sampled data.

E. For the frequency range above 50 Hz, either SEA or FEM may be used. SEA models shall use a loss factor coefficient of 0.5% unless alternative values are justified by payload test. FEM models are to be used to the highest frequency verified by test. FEM models may also be used beyond the range verifiable by test to envelope possible attached payload response as an alternative to SEA. Test data analysis may be used to adjust the damping coefficient used in either FEM or SEA models or to adjust the coupling coefficients and loss factor used for SEA models.

F. Disturbance forces must be applied to transfer functions from Force/Moment Spectral Density (FSD) form for each one–third octave. The RSS value for each incremental division of FSD(f) contribution of multiple sources, wide–band and narrow–band, are to be added to yield a total FSD(f) for each frequency subdivision before Frms is calculated. Values are given either as wide–band (an RMS value and a frequency range) or as narrow–band (an rms value and a discrete frequency). Wide–band RMS one–third octave data are to be converted to FSD(f) per the following equation:

$$\boxed{FSD(f) = \frac{Frms^2}{\Delta fto}}$$

Where Frms is the Data base rms force value and Δfto is the bandwidth of the one–third octave band. Narrow–band data base values are to be converted to FSD(f) by the same expression adding the data base rms value only in the single frequency subdivision spanning the data base frequency. The FSD(f) contribution for multiple sources, wideband and narrowband, are to be added to yield a total FSD(f) for each frequency subdivision before Frms is calculated for each translation or moment degree of freedom.

The use of separate force and moment limits requires determination of the phase of interface response at each interface point. Forces are to be calculated as the algebraic sum of the component interface forces, calculated separately for each axis. Moments are to be calculated with respect to the capture latch location by summing the cross product of complex force responses by the moment arm vector from the capture latch to each interface point.

Verification is successful when the analysis or test results show that the interface forces are less than the limits specified in paragraph 3.1.3.2.6.2.1.

4.3.1.3.2.6.2.2 TRANSIENT REQUIREMENTS

Verification of the maximum transient impulse limit is to be performed by method A. Verification of maximum force limit is to be performed by Method B.

A. Verification of maximum transient impulse shall be by analysis or test. Acceptable test methods are defined in SSP **TBD**, Appendix E.. Verification shall be considered successful when the impulse delivered by an attached payload over any 10 second period is shown to be less than 10 lb s (44.5 N s) and when the sum of the impulse and vibration resulting from the impulse do not exceed the vibratory limits of 3.1.5.2 over any 100 second period. FEM time domain analysis is an acceptable verification method for this requirement as defined in 4.3.1.5.2. Acceleration or force response test data is acceptable if interface impedance considerations are included, including adjustment for possible modal frequency shift and interface structural amplification or attenuation.

B. The maximum force at the attached payload interface, as determined by either analysis or test, shall be less than 1000 lb (4448 N) in any direction. Rigid body analysis may be used if it can be shown that the rigid payload force to a rigid interface will not exceed 500 lb (2224 N). Otherwise, FEM payload analysis using a Payload Project Office supplied ISS model must be used to show that the flexible interface force will not exceed 1000 lb (4448 N).

4.3.1.3.2.6.3 ANGULAR MOMENTUM LIMITS

NVR

4.3.1.3.2.6.3.1 LIMIT INDUCED ISS ATTITUDE RATE

This requirement shall be verified by analysis. The analysis shall consist of a comparison of the calculated angular momentum impulse due to individual payload on–board disturbances to the per axis angular momentum allocations to verify that the allocations are not exceeded. The disturbance angular momentum impulse will normally be calculated as the integral of the disturbance torque relative to the ISS Assembly Complete center of mass over the specified period of time. For constant, continuously increasing, or continuously decreasing disturbance torques over two or more adjacent time periods, the difference in angular momentum impulse of the adjacent time periods should be used. Each attached payload source may be verified independently against the nine minute limit. Each attached payload shall be verified under worst–case combined source conditions against the two minute and ten second limits. ISS assembly complete mass properties and worst case element location/design parameters should be used when assessing compliance with this requirement. The verification shall be considered successful when analysis shows that the per axis disturbance angular momentum impulses are specified for each axis.

4.3.1.3.2.6.3.2 LIMIT DISTURBANCE INDUCED CMG MOMENT USAGE

This requirement shall be verified by analysis utilizing analytical models of the disturbance. This analysis shall consist of calculating the angular momentum impulse for each axis due to individual payload on–board disturbances and applying them in the specified equation for estimating worst case CMG momentum usage. The disturbance angular momentum impulse will normally be calculated as the integral of the disturbance torque relative to the ISS Assembly Complete center of mass over the specified period of time. For constant, continuously increasing, or continuously decreasing disturbance torques over two or more adjacent 110 minute periods, the difference in angular momentum impulse of the adjacent 110 minute periods should be used. ISS assembly complete mass properties and worst case element location/design parameters (location and orientation producing the greatest H impulse vector with respect to the requirement of Table 3.1.3.2.6.3.2–1) should be used when assessing compliance with this requirement. The verification shall be considered successful when analysis shows that the estimated worst case CMG momentum usage is less than the specified amount.

4.3.1.3.2.7 CONTACT SURFACES

Verification shall be by inspection of the production drawings to verify that the Attached Payload Capture Bar, Guide Pins and passive half platform subject to contact are coated with a dry film lubricant and provide a .25" minimum edge radius in accordance with SSP 57004.

4.3.1.4 INTERFACE WITH SPACE STATION EXTRAVEHICULAR ROBOTICS

4.3.1.4.1 INTERFACE WITH NSTS REMOTE MANIPULATOR SYSTEM AND SPACE STATION REMOTE MANIPULATOR SYSTEM

Translation of the robotic arm with the Attached Payload on ISS shall be verified by analysis. The robotics analysis using MAJIK (or an equivalent tool) shall be based on review of the ISS traffic model, system design and flight element drawings and the data from functional interface test and dynamic simulations conducted during end item certification activities. The analysis shall be considered successful when data shows that the robotic arm with the Attached Payload can translate along a ISS translation corridor without violating the EVR clearance requirements of SSP 30550 and SSP 42004.

4.3.1.4.1.1 GRAPPLE FIXTURE LOCATIONS

The accommodation of grapple fixtures on the Attached Payload shall be verified by inspection. The inspection shall be based upon documentation defining the required grapple fixture(s), the Attached Payload flight drawings, and the unique ICD. An inspection of Attached Payload flight drawings shall be performed to ensure that all grapple fixture interfaces are in accordance with SSP 30550, SSP 42004, and the location constraints of the unique ICD. The inspection shall be considered successful when the Attached Payload flight drawings document that all grapple fixtures are in accordance with SSP 30550, SSP 42004, and the unique ICD.

4.3.1.4.1.2 GRAPPLE FIXTURE STRUCTURAL SUPPORT

An analysis shall be performed of the Attached Payload structure production drawings to verify that the grapple fixture accommodations are in accordance with section 3.7 and with SSP 30559 are provided. When it is shown that the requirements as specified in section 3.7 and SSP 30559 have been met, then the verification shall be satisfied.

4.3.1.4.2 INTERFACE WITH SPECIAL PURPOSE DEXTEROUS MANIPULATOR

Translation of the SPDM robotic arm with Attached Payload equipment or ORUs shall be verified by analysis. The analysis shall be based on review of the ISS traffic model, system design and flight element drawings and the data from functional interface test and dynamic simulations conducted during end item certification activities. The analysis shall be considered successful when data shows that the SPDM robotic arm with the Attached Payload equipment or ORUs can translate without violating EVR clearance requirements.

4.3.1.4.2.1 SPECIAL PURPOSE DEXTEROUS MANIPULATOR FIXTURE LOCATIONS

A. The accommodation of SPDM fixtures (i.e., microconicals) on the Attached Payload shall be verified by inspection. The inspection shall be based upon documentation defining the required SPDM fixture(s), the Attached Payload flight drawings, and SSP 57004.

B. An inspection of Attached Payload flight drawings shall be performed to ensure that all SPDM fixture interfaces are in accordance with SSP 42004 and the location constraints of SSP 57004. The inspection shall be considered successful when the Attached Payload flight drawings document that all SPDM fixtures are in accordance with SSP 42004 and SSP 57004.

4.3.1.4.2.2 SPECIAL PURPOSE DEXTUROUS MANIPULATOR FIXTURE STRUCTURAL SUPPORT

An analysis shall be performed of the Attached Payload structure production drawings to verify that the SPDM fixture accommodations are provided in accordance with section 3.7 and SSP 30559. When it is shown that the requirements as specified in section 3.7 and in SSP 30559 have been met, then the verification shall be satisfied.

4.3.2 ELECTRICAL INTERFACE REQUIREMENTS

4.3.2.1 ELECTRICAL INTERFACE WITH MOBILE SERVICING SYSTEM MCAS

NVR

4.3.2.2 ELECTRICAL POWER INTERFACE WITH THE ITS S3 PAYLOAD ATTACH SYSTEM AND P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

NVR

4.3.2.2.1 ELECTRICAL POWER CHARACTERISTICS

NVR

4.3.2.2.1.1 STEADY–STATE VOLTAGE CHARACTERISTICS

Verification of compatibility with steady–state voltage limits shall be performed by test at low and high input voltage values of 112.5 to 126 Vdc. The Attached Payload shall be operated under selected loading conditions that envelope operational loading. The verification shall be considered successful when the test shows under low and high voltage conditions the Attached Payload is compatible with the steady–state voltage limits of 112.5 to 126 Vdc.

Verification may be performed by the PRCU or NASA approved equivalent.

4.3.2.2.1.2 RIPPLE VOLTAGE CHARACTERISTICS

4.3.2.2.1.2.1 RIPPLE VOLTAGE AND NOISE

Ripple voltage and noise requirements shall be verified by analysis. The verification shall be considered successful when the CS–01 test per SSP 30238 shows the Attached Payload operates and is compatible with the EPS time domain ripple voltage and noise level of at least 2.5 Vrms within the frequency range of 30 Hz to 10 kHz.

Verification may be performed by the PRCU or equivalent.

4.3.2.2.1.2.2 RIPPLE VOLTAGE SPECTRUM

Ripple voltage spectrum requirements shall be verified by Analysis. Verification shall be considered successful when analysis of the CS–01 and CS–02 test data per SSP 30238, generated as a result of paragraph 4.3.2.2.4 of this document, shows the Attached Payload at interface C is compatible with the ripple voltage spectrum in Figure 3.2.2.1.2.2–1 of this document.

4.3.2.2.1.3 TRANSIENT VOLTAGES

4.3.2.2.1.3.1 NORMAL TRANSIENT VOLTAGES

Transient voltages shall be verified by test or analysis. Input voltage shall be 112.5 Vdc and 126 Vdc with the Interface C source impedance, as specified in SSP 30482, Volume I. Verification of compatibility with the specified transient voltages shall be performed by test or analysis of the Attached Payload operation across the transient envelope as specified in Figure 3.2.2.1.3.1–1 of this document. The verification shall be considered successful when the test or analysis shows the Attached Payload is compatible with the EPS transient voltage characteristics as specified in Figure 3.2.2.1.3.1–1.

4.3.2.2.1.3.2 FAULT CLEARING AND PROTECTION

Fault clearing and protection shall be verified by analysis. The verification shall be considered successful when analysis shows the Attached Payload at Interface C does not produce an unsafe condition or one that could result in damage to ISS equipment or Attached Payload hardware from the EPS transient voltages as specified in Figure 3.2.2.1.3.2–1 of this document.

4.3.2.2.1.3.3 INTERFACE C NON–NORMAL VOLTAGE RANGE

A. Verification of compatibility with maximum overvoltage conditions shall be performed by analysis. The analysis shall ensure the Attached Payload will not produce an unsafe condition or one that could result in damage to ISS equipment external to the Attached Payload when parameters are as specified in paragraph 3.2.2.1.3.3. The analysis should be performed with all converters directly downstream of Interface C. The verification shall be considered successful when analysis shows that Attached Payload is safe within ISS interface conditions as defined in paragraph 3.2.2.1.3.3.

B. Verification of compatibility with undervoltage conditions shall be performed by analysis. The analysis shall ensure the Attached Payload will not produce an unsafe condition or one that could result in damage to ISS equipment external to the Attached Payload when parameters are as specified in paragraph 3.2.2.1.3.3. The analysis should be performed with all converters directly downstream of Interface C. The verification shall be considered successful when analysis shows the Attached Payload is safe within ISS interface conditions as defined in paragraph 3.2.2.1.3.3.

4.3.2.2.2 ELECTRICAL POWER INTERFACE

4.3.2.2.2.1 ATTACHED PAYLOAD CONNECTORS AND PIN ASSIGNMENTS

A. Attached Payload to ISS Connectors shall be verified by inspection and demonstration. The verification shall be considered successful when an inspection of the Attached Payload specifications and drawings shows the Attached Payload connector plug is the Passive UMA connector NUR1–005 or NASA approved equivalent meets the requirements for this connector as defined in SSQ 21637.

B. Pin Assignments shall be verified by inspection and demonstration. The verification shall be considered successful when an inspection of the Attached Payload specifications and drawings shows the Attached Payload connector plug is the Passive UMA connector NUR1–005 or NASA approved equivalent meet the pin assignments and avionics interface terminations as specified in the unique payload hardware ICD per SSP 57004 and demonstrates successful mating with the active UMA connector on the common attach system interface verification test article.

4.3.2.2.2.2 POWER BUS ISOLATION

A. Verification of Power Bus Isolation between two independent ISS Power feeds as specified, shall be performed by analysis. The verification shall be considered successful when the analysis shows the Attached Payload, with a source voltage of + 126 Vdc, and its internal and external Attached Payload EPCE provides a minimum of 1–megohm isolation in parallel with not more than 0.03 microfarads of mutual capacitance between the two independent power feeds including both the supply and return lines and that no single failure shall cause the independent power feeds to be electrically tied.

B. Verification of power bus isolation without the use of diodes shall be verified by analysis. The analysis shall show the exclusion of diodes used to isolate the two independent ISS power bus high side or return lines. The verification shall be considered successful when analysis shows there are no diodes used to electrically tie together independent ISS power bus high side or return lines within the Attached Payload and its internal and external EPCE.

4.3.2.2.2.3 COMPATIBILITY WITH SOFT START/STOP REMOTE POWER CONTROLLER

Compatibility with soft start/stop RPC(s) shall be verified by test. Verification of initialization with soft start/stop performance characteristics shall be performed by test when the initial supply of power is provided to the equipment connected to the RPC(s). Input power to the Attached Payload shall be delivered through a PRCU or equivalent. The Attached Payload connected to interface C shall be operated with multiple load combinations at levels ranging from 0% to 100% of the RPC rated conductivity. Verification may be performed by the PRCU or NASA approved equivalent.

4.3.2.2.2.4 SURGE CURRENT

A. Surge Current amplitude shall be verified by test and analysis. Input power to the Attached Payload should be representative of the ISS power environment. Verification of compatibility with Surge Current limits shall be performed by test at high, nominal, and low input voltage values as specified. The power source used to perform the test shall be capable of providing a range of power between 0 kiloWatt (kW) to 3 kW at 112.5–126. The Attached Payload EPCE shall be operated under selected loading conditions that envelope operational loading. The analysis shall be performed using test data from the above test. The analysis shall indicate operability and compatibility exist based on test data and the requirements specified in paragraph 3.2.2.2.4. The verification shall be considered successful when test and analysis shows under high, nominal and low voltage conditions the Attached Payload can perform all functional capabilities and prove compatibility by operating within the specified limits of paragraph 3.2.2.2.4. Verification may be performed by the PRCU or NASA approved equivalent.

B. Surge Current rate of current change shall be verified by test and analysis. Input power to the Attached Payload should be representative of the ISS power environment. Verification of compatibility with Surge Current limits shall be performed by test at high, nominal, and low input voltage values as specified. The power source used to perform the test shall be capable of providing a range of power between 0 kW to 3 kW at 112.5–126. The Attached Payload EPCE shall be operated under selected loading conditions that envelope operational loading. The analysis shall be performed using test data from the above test. The analysis shall indicate that operability and compatibility exist based on test data and the requirements specified in paragraph 3.2.2.2.4. The verification shall be considered successful when test and analysis shows under high, nominal and low voltage conditions the Attached Payload can perform all functional capabilities and prove compatibility by operating within the specified limits of paragraph 3.2.2.2.4. Verification may be performed by the PRCU or NASA approved equivalent.

4.3.2.2.2.5 REVERSE ENERGY/CURRENT

Reverse Energy/Current shall be verified by analysis. Input power to the Attached Payload should be representative of the ISS power environment. Verification of compatibility with Reverse Energy/Current limits shall be performed by analysis at 3 kW values corresponding to the Attached Payload design. The power source used to perform the analysis shall be capable of providing a range of power between 0 kW to 3 kW at 112.5–126 Vdc. The Attached Payload shall be analyzed under selected loading conditions that envelope operational loading. The verification will be considered successful when analysis shows that the Attached Payload complies with requirements defined in Table 3.2.2.2.5–1 for the reverse energy/current into the upstream power source. Also, when the reverse energy or the reverse current requirement for all environmental conditions specified in this document when powered from a voltage source with characteristics specified in paragraphs 3.2.2.1 and 3.2.2.2 with a source impedance of 0.1 ohm is met.

4.3.2.2.2.6 CIRCUIT PROTECTION DEVICES

4.3.2.2.2.6.1 INTERNATIONAL SPACE STATION ELECTRICAL POWER SYSTEM CIRCUIT PROTECTION CHARACTERISTICS

A. Tests shall be performed to show the Attached Payload connected to an Interface C electrical interface operates and is compatible with the characteristics shown and described in Figure 3.2.5–1 of SSP 57004, with the exception that the Auxiliary U.S. Laboratory (USL) current–limiting and trip curve in Figure 3.2.5–1 applies to both the power feeds at S3/P3 Attach site locations. The tests shall be performed at initiation of power to the Attached Payload and with multiple internal load combinations. The verification shall be considered successful if the test results show the initial current flow, when powered on, to the Attached Payload and current flow during the Attached Payload operations with multiple internal load does not exceed the current magnitude and duration as defined and described in Figure 3.2.5–1 of SSP 57004, with the exception that the Auxiliary USL current–limiting and trip curve in Figure 3.2.5–1 applies to both the power feeds at S3/P3 Attach site location.

B. Analysis of electrical circuit schematics shall be performed to show overcurrent protection exists at all points in the Attached Payload electrical architecture system where power is distributed to lower level (wire size not protected by upstream circuit protection device) feeder and branch lines. The analysis shall be considered successful when results show overcurrent protection exists at each point in the Attached Payload electrical architecture system where power is distributed to lower level (wire size) feeder and branch lines.

4.3.2.2.2.6.2 ATTACHED PAYLOAD TRIP RATINGS

The Attached Payload Trip Ratings shall be verified by test and demonstration. Input power to the Attached Payload shall be representative of the ISS power environment. The test and demonstration shall be performed as specified in paragraph 3.2.2.2.6.1. The verification shall be considered successful when test and demonstration of the Attached Payload shows that the overcurrent which trips the circuit protection in a downstream device will not also trip the protection device upstream.

4.3.2.2.2.7 INTERFACE C ATTACHED PAYLOAD COMPLEX LOAD IMPEDANCES

Attached Payload load impedance shall meet the amplitude and phase requirements as specified in Figure 3.2.2.2.7–1 and 3.2.2.2.7–2. If downstream devices can be shown to have negligible effect on load impedance magnitude and phase, or be realistically simulated by passive devices, then simulated loads may be used as downstream devices for test. Load impedance shall be tested under conditions of high, nominal, and low voltage to the integrated Attached Payload system. The active converters directly downstream shall also be exercised through the complete range of their loading. Selected combinations of converters that can influence the measured load impedance at Interface C shall be tested.

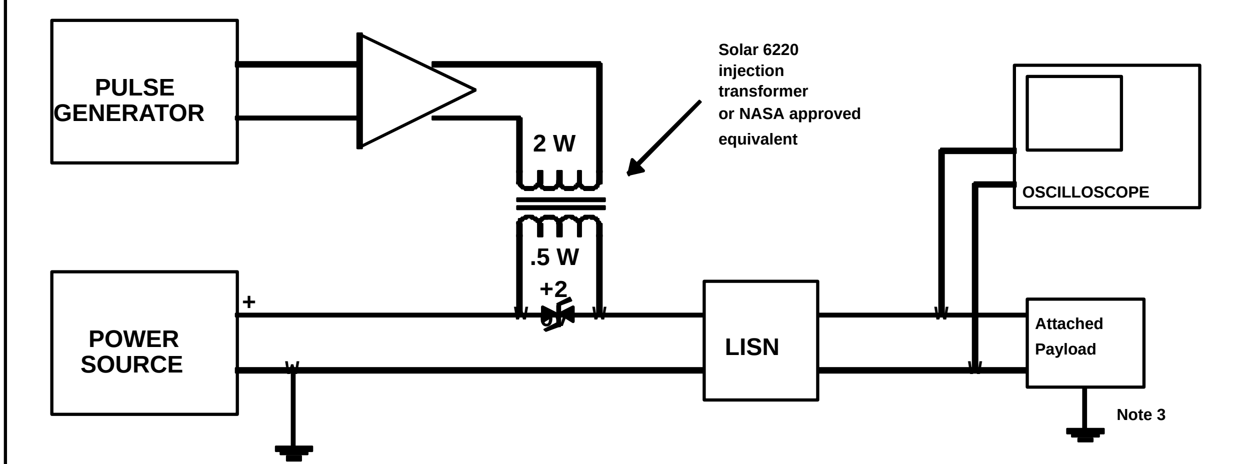
The verification shall be considered successful when the test shows that all load impedances measured for high, nominal and low voltage conditions remain within specified limits identified by Note 1 in Figures 3.2.2.2.7–1 and 3.2.2.2.7–2.

4.3.2.2.2.8 LARGE SIGNAL STABILITY

Large signal stability shall be verified by test and analysis. A large signal stability test shall be conducted for the Attached Payload connected to Interface C. An integrated analysis shall be provided for representative maximum and minimum power loading to demonstrate that impedance variations will not impact system stability. The input and transient response waveform for the Attached Payload shall be recorded from the start of the pulse through the time when the transient diminishes to and remains below 10 percent of the maximum amplitude of the response.

The required test conditions may be produced using a programmable power source or the test configuration shown in Figure 4.3.2.2.2.8–1. The 25 amp ISS Line Impedance Simulation Network (LISN) or equivalent shown in Figure 4.3.2.2.2.8–2 will be used. The pulse generator/amplifier must provide a source impedance of less than 0.2 ohms from 100 Hz to 10 kHz to the 2 ohm load of the primary side of the pulse transformer. Pulses of 100, 125 and 150 microsecond (±10 microsecond) duration shall be applied. The pulse amplitude at the secondary side of the injection transformer should be between 10 and 15 Volts. Pulse rise and fall times must not exceed 10 microseconds between 10 and 90 percent of the pulse amplitude. The resulting transient responses must remain within the EPS normal transient limits.

The test and analysis shall be considered successful when results show transient responses, measured at the input to the Attached Payload, diminish to 10 percent of the maximum amplitude within 1.0 milliseconds and remain below 10 percent thereafter.



NOTES: 1. The output of the pulse generator must be applied to the transformer through a drive amplifier capable of providing an output impedance of 0.2 ohms, or less, from 100 Hz to 10 kHz.
2. The drive amplifier should be capable of delivering at least 75 watts rms into a 4 Ohm load and be suitable for EMC CS–01 tests.
3. Chassis of the Attached Payload must be grounded.
4. Pulse generator, injection transformer and Zener diode may require adjustment to generate the test pulses and to protect the Attached Payload under test.

Figure 4.3.2.2.8–1 STABILITY TEST SETUP, TRANSIENT RESPONSES

FIGURE 4.3.2.2.2.8–1 STABILITY TEST SETUP, TRANSIENT RESPONSES

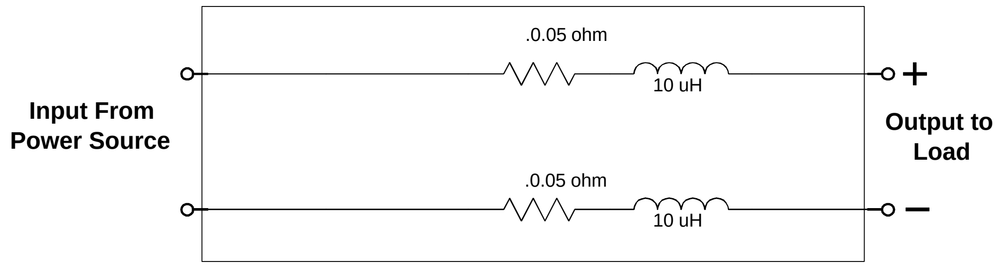


FIGURE 4.3.2.2.2.8–2 INTERNATIONAL SPACE STATION LINE IMPEDANCE SIMULATION NETWORK

4.3.2.2.3 ELECTRICAL POWER CONSUMER CONSTRAINTS

4.3.2.2.3.1 WIRE DERATING

Wire Derating shall be verified by analysis. Analysis of the Attached Payload electrical power schematics shall be performed to show that the wire gauge at the Attached Payload to ISS power interface or Attached Payload EPCE meets the requirement of paragraph 3.2.2.3.1. The verification shall be considered successful when the analysis shows the Attached Payload to ISS power interface or Attached Payload EPCE meets Wire Derating requirement as specified in paragraph 3.2.2.3.1.

4.3.2.2.3.2 EXCLUSIVE POWER FEEDS

The Attached Payload design with exclusive power feeds shall be verified by demonstration and inspection. The demonstration shall be considered successful when the result shows each individual Attached Payload will be provided power from its dedicated Attached Payload to ISS power interface location and no intra–site cabling exists. The inspection shall be considered successful when the result shows each individual S3/P3 attach site input power cabling will interface to a dedicated Attached Payload to ISS power interface and no cabling from external source(s) exists.

4.3.2.2.3.3 LOSS OF POWER

Verification that the Attached Payload equipment connected to Interface C meets the loss of power safety requirements specified in NSTS 1700.7 ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.2.2.4 ELECTROMAGNETIC COMPATIBILITY

The requirements of SSP 30243, Space Station Requirements for Electromagnetic Compatibility, paragraphs 3.1 and 3.6.2 shall be verified by test and analysis. The test shall be considered successful when results show the Attached Payload connected to Interface C meet the requirements specified in SSP 30243 paragraph 3.6.2. The results of the EMC test shall be documented in the EMC test plan/report. The analysis shall be documented in an EMC Control Plan and Design Analysis Report. The analysis shall include determining the necessary requirements for equipment not connected directly to Interface C such that the entire payload meets the EMC requirements of this IRD. The analysis shall be considered successful when results show that requirements defined in paragraph 3.1 of SSP 30243 have been met.

Note:

A. The Control Plan and the Design Analysis Report can be combined into one document per payload provider format.

B. Clarifications to SSP 30243, paragraph 3.6.2:

- Only the impedance characteristics of the power source need to simulated
- Only representative simulated signals and loads for the interface tests are required
- Verification of the on–orbit configuration of the integrated rack may be performed analytically if and only if the on–orbit configuration differs from the Qualification Test configuration

C. Details of the EMC Control Plan, Design Analysis Report, and EMC Test Plan/Report are located in SSP 57013, Generic Attached Payload Verification Plan.

D. If analysis shows requirements of paragraph 3.6.2 of SSP 30243 are met during Attached Payload EMI testing, as defined in paragraph 3.2.2.4 of this document, a separate EMC test plan/report is not needed.

4.3.2.2.4.1 ELECTRICAL GROUNDING

The Electrical Grounding of the Attached Payload EPCE shall be verified by test and analysis. The test shall be considered successful when the results show that Attached Payload grounding is in compliance with the requirements in section 3 of SSP 30240, Space Station Requirements Grounding. The analysis shall be based on end item qualification data and Attached Payload EPCE design and analysis data. The analysis shall be considered successful when the data shows the Attached Payload EPCE is electrically grounded within the requirements of section 3 of SSP 30240.

4.3.2.2.4.2 ELECTRICAL BONDING

The Electrical Bonding of the Attached Payload EPCE shall be verified by Test, Analysis and Inspection. The test shall be considered successful when the results show the requirements of SSP 30245 and the requirements of NSTS 1700.7 ISS Addendum in sections 213 and 220 are met. The analysis shall be based on end item qualification data and Attached Payload EPCE design and analysis data. The analysis shall be considered successful when the data shows the Attached Payload EPCE is electrically bonded within the requirements of SSP 30245 and the requirements of NSTS 1700.7 ISS Addendum in sections 213 and 220 are met. The inspection shall be based on the Attached Payload EPCE design drawings and any applicable analysis and test reports. The inspection shall be considered successful when the requirements of SSP 30245 and the requirements of NSTS 1700.7 ISS Addendum in sections 213 and 220 are met.

The class R bond at the Guide Pin to Guide Vane interface shall be verified by Analysis. The analysis shall include a review of Attached Payload design drawings, design and analysis data and any applicable test data. The analysis shall be considered successful when the data shows that the Attached Payload Guide Pins meet the material and surface preparation/finish requirements of SSP 30245, paragraphs 3.2.1.2, 3.3.4, 3.3.5 and 3.3.6, the Guide Pin dimensions meet the requirements of SSP 57004, figure 3.1.2.2–1 and the Attached Payload PAS interface stiffness meets the requirement specified in paragraph 3.1.3.1.3.2 of this document.
Note: An Attached Payload interface meeting these requirements is considered capable of achieving a class R bond at the Guide Pin to Guide Vane interface based on the results of the CAS Interface Class R Bonding Test documented in test report MDC 02H1044, Common Attach System Interface Class R Bonding Test Report.

4.3.2.2.4.3 CABLE/WIRE DESIGN AND CONTROL REQUIREMENTS

The Cable and Wire Design of the Attached Payload EPCE external cables shall be verified by Test, Analysis, or Inspection. The test shall be considered successful when the results show all requirements of SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility, are met. The analysis shall be based on Attached Payload design and analysis data. The analysis shall be considered successful when the results show all requirements of SSP 30242 are met. The inspection shall be based on physical/visual indications of the Attached Payload EPCE. The inspection shall be considered successful when physical/visual indications show that external cable and wire design is in compliance with the requirements can normally be met by inspection of drawings and hardware. Analysis is required to determine impedance and sensitivity characteristics of the circuit when classification cannot be determined by examination of the circuit known characteristics.

Note: SSP 30242 harness requirements can normally be met by inspection of drawings and hardware. Analysis is required to classify signals and determine the necessary isolation between signals. Test may be required to determine impedance and sensitivity characteristics of the circuit when classification cannot be determined by examination of the circuit known characteristics.

4.3.2.2.4.4 ELECTROMAGNETIC INTERFERENCE

The Electromagnetic Interference of the Attached Payload EPCE shall be verified by test and analysis. Tests shall be performed and data submitted for conducted susceptibility and radiated susceptibility, in addition to that for conducted emissions and radiated emissions. This data shall be evaluated against the limits of SSP 30237. The test shall be considered successful when the tests are performed using SSP 30238 and the results show requirements of SSP 30237 are met by the Attached Payload. The test results shall be documented in the EMI test plan/report. The analysis of each Attached Payload to ISS power interface shall be performed using equipment test data as mentioned in the above paragraph. The analysis shall be considered successful when the results show requirements of SSP 30237 are met by the Attached Payload. This analysis includes evaluating the degree of isolation from 30 Hz to 400 MHz provided by the Attached Payload EPCE for power ripple and transients to the equipment using isolated power. An analysis of the isolation in conjunction with the equipment conducted requirements should be submitted in the EMC Control Plan to verify the requirements of this IRD are met.

Note: EMI test plan/report details are located in SSP 57013.

4.3.2.2.4.5 ELECTROSTATIC DISCHARGE

A. NVR

B. The labeling of unpowered Attached Payload EPCE shall be verified by inspection. The inspection shall be considered successful when physical/visual indications show the labeling of Attached Payload EPCE susceptible to ESD up to 15000 V is in accordance with MIL–STD–1686A.

4.3.2.2.4.6 ALTERNATING CURRENT MAGNETIC FIELDS

The AC Magnetic Fields requirement for the Attached Payload connected to Interface C, including cables and interconnecting wiring, shall be verified by test.

The test shall be performed using the MIL–STD–462D, Measurement of EMI Characteristics, RE01 Method with the following modifications:

A. Test setup guidelines shall be per SSP 30238, Space Station Electromagnetic Techniques, Figure 3–9 or 3–10, not the setup identified by MIL–STD–462D.

B. Guidelines of SSP 30238, Figure 3–9 and 3–10, requirement of 1 meter separation does not apply to RE01.

C. Measurements are required from 30 Hz to 50 kHz rather than 100 kHz required by MIL–STD–461D, Electromagnetic Emission and Susceptibility Requirements for Control of Electromagnetic Interference.

D. Measurements are performed at 7 cm from the generating equipment. In the event emissions are out–of–specification, measurements are performed at 50 cm from the generating equipment.

E. Emissions greater than 20 dB below the specified limits shall be recorded in the EMI test report. In cases where the noise floor and ambient are not 20 dB below specified level, only those emissions above the noise floor/ambient are required to be recorded.

The verification shall be considered successful when test results show the generated ac magnetic fields of the Attached Payload connected to Interface C, including cables and interconnecting wiring, do not exceed 140 dB above 1 picotesla between 30 Hz to 2 40 dB per decade to 50 kHz.

4.3.2.2.4.7 DIRECT CURRENT MAGNETIC FIELDS

The DC magnetic fields requirement for Attached Payloads with electromagnetic and/or permanent magnetic devices shall be verified by test or analysis. The measurement or analysis of DC magnetic fields shall be performed if there is a DC magnetic field greater than 170 dB above 1 picotesla. Additional measurements or analysis shall be performed at 10 cm increments away from the generating equipment until data proves the DC magnetic fields are 6 dB below the 170 dB above 1 picotesla requirement. The verification shall be considered successful when test or analysis results show the generated dc magnetic fields of the Attached Payload do not exceed 170 dB above 1 picotesla at a distance of 7 cm from the external surfaces of the Attached Payload. The includes electromagnetic and permanent magnetic devices.

4.3.2.2.4.8 CORONA

Attached Payload equipment with voltages (steady–state, transient, internal, or external) greater than 190 volts shall be verified by test to the degree necessary to ensure no permanent damaging effects and no hazardous conditions due to destructive corona will exist in the partial pressure environment above 1.93E–05 pounds per square inch absolute (psia) (1.0E–03 Torr). The fault clearing and protection transient voltage limits defined in Paragraph 3.2.2.1.3.2–1 is not considered the equipment voltage.

4.3.2.2.4.9 ELECTROMAGNETIC INTERFACE SUSCEPTIBILITY FOR SAFETY–CRITICAL CIRCUITS

Safety critical circuits should be verified by test and analysis. The analysis shall be considered successful when the results show the requirements of SSP 30243, paragraph 3.2.3 are met by the Attached Payload.

4.3.2.2.5 SAFETY REQUIREMENTS

4.3.2.2.5.1 PAYLOAD ELECTRICAL SAFETY

Verification shall be by analysis. The analysis showing that the Attached Payload meets the requirements of NSTS 1700.7 ISS Addendum shall be submitted to the PSRP in accordance with NSTS 13830, Implementation Procedure for NSTS Payload System Safety Requirements. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased reviews are approved.

4.3.2.2.5.1.1 MATING/DEMATING OF POWERED CONNECTORS

Verification that the Attached Payload for mating/demating of powered connectors specified in NSTS 18798, MA2–99–170, Crew Mating/Demating of Powered Connectors, shall be performed and submitted to the PSRP in accordance with NSTS 13830, Implementation Procedure for NSTS Payloads System Safety Requirements. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.2.2.5.1.2 SAFETY CRITICAL CIRCUITS REDUNDANCY

Verification that the Attached Payload equipment connected to Interface C meets the loss of power safety requirements specified in NSTS 1700.7 ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.2.2.5.2 POWER SWITCHES/CONTROLS

A. Verification shall be by analysis and test of the Attached Payload switches/controls connected to Interface C performing on/off power functions. Verification shall be considered successful when the analysis and test confirm that the on/off functions open (dead–face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power–off position.

B. An analysis of the Attached Payload design drawings shall be performed to verify that power–off markings and/or indications are used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit. Verification shall be considered successful when the analysis confirms the equipment has been met.

C. Verification shall be by inspection. The Attached Payload design drawings shall be inspected to verify that standby, charging or other appropriate nomenclature was used to indicate that the supply circuit is not completely disconnected for this power condition. Verification shall be considered successful when the inspection verifies that the proper nomenclature was used.

4.3.3 COMMAND AND DATA HANDLING INTERFACE REQUIREMENTS

NVR

4.3.3.1 COMMAND AND DATA HANDLING INTERFACE WITH MOBILE SERVICING SYSTEM

Verification of the Attached Payload interface to the UMA shall be by test. Verification shall be considered successful when the test shows that the Attached Payload can transmit and receive data from the ISS in accordance with SSP 42004, paragraph B3.2.2.6.

4.3.3.2 COMMAND AND DATA HANDLING INTERFACE WITH THE INTEGRATED TRUSS SEGMENT S3 PAYLOAD ATTACH SYSTEM AND P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

NVR

4.3.3.2.1 WORD/BYTE NOTATIONS, TYPES AND DATA TRANSMISSIONS

Information only, NVR

4.3.3.2.1.1 WORD/BYTE NOTATIONS

Verification of the Attached Payload word/byte notations shall be by inspection and test. The inspection shall consist of a review of the word/byte notations in the unique payload software ICD and should be considered successful when it is shown that the word/byte notations used in that ICD conform with paragraph 3.1.1, Notations of SSP 52050. Verification shall be considered successful when the AP communicates on the required telemetry links with the PRCU, STEP, or equivalent.

4.3.3.2.1.2 DATA TYPES

Verification of the Attached Payload data types shall be by inspection. The inspection shall consist of a review of the data types against paragraph 3.2.1 and subparagraphs, Data Formats, of SSP 52050. Verification shall be considered successful when it is shown that the data types in the unique Attached Payload software ICD conforms with paragraph 3.2.1 and subparagraphs, Data Formats, of SSP 52050.

4.3.3.2.1.3 DATA TRANSMISSIONS

A. Verification of the LRDL transmissions shall be by inspection. The inspection shall consist of a review of the LRDL data transmissions against paragraph 3.4, Non–Signal Data Coding Standards, of D684–10056–01. Verification shall be considered successful when it is shown that the word/byte notations in the unique payload software ICD conforms with SSP 52050, paragraph 3.1.2 and paragraph 3.4, Non–Signal Data Coding Standards, of D684–10056–01.

B. Verification of the HRDL transmissions shall be by inspection. The inspection shall consist of a review of the HRDL data transmissions against paragraph 1.6, Bit Numbering Convention and Nomenclature, of CCSDS 701.0–B–2. Verification shall be considered successful when it is shown that the word/byte notations in the unique payload software ICD conforms with SSP 52050, paragraph 3.4.1 paragraph 1.6, Bit Numbering Convention and Nomenclature, of CCSDS 701.0–B–2.

4.3.3.2.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS

NVR

4.3.3.2.2.1 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA

A. Verification of the Attached Payload CCSDS data that is transmitted from space to ground shall be by analysis or test. The analysis shall consist of a review of the CCSDS data in the software design documentation. The test shall consist of a data transmission with the PRCU, STEP, or equivalent and inspection of the transmitted data against the SSP 52050 formats. Analysis shall be considered successful when it is shown that in the software design documentation the Attached Payload data which is transmitted space to ground is CCSDS data packet format. Test shall be considered successful when the PRCU, STEP or equivalent correctly receives the Attached Payload CCSDS data.

B. Verification of the Attached Payload CCSDS data that is transmitted ground to space or from the S3/P3 Attach Sites to the Payload MDM shall be by analysis or test. The analysis shall consist of a review of the CCSDS data in the software design documentation. The test shall consist of a data transmission with the PRCU, STEP, or equivalent and inspection of the transmitted data against the SSP 52050 format. Analysis shall be considered successful when it is shown that in the software design documentation the Attached Payload data which is transmitted ground to space or from the S3/P3 attach sites to the payload MDM are CCSDS data packets. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload CCSDS data.

4.3.3.2.2.1.1 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA PACKETS

Verification of the Attached Payload CCSDS data packet shall be by inspection and test. Inspection shall be considered successful when it is shown that the CCSDS data packets in the unique Attached Payload software ICD conforms with SSP 52050 and SSP 57002. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload CCSDS data packets.

4.3.3.2.2.1.1.1 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS PRIMARY HEADER

Verification of the Attached Payload CCSDS primary header shall be by inspection and test. The test shall consist of a data transmission with the PRCU, STEP, or equivalent and inspection of the transmitted data against the SSP 52050 formats. Test shall be considered successful when the PRCU, STEP, equivalent correctly receives the Attached Payload CCSDS primary header.

4.3.3.2.2.1.1.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS SECONDARY HEADER

A. Verification of the Attached Payload CCSDS secondary header shall be test. The test shall consist of a data transmission with the PRCU, STEP, or equivalent and inspection of the transmitted secondary header immediately following the CCSDS primary header. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload CCSDS secondary header.

B. Verification of the Attached Payload CCSDS secondary header shall be by test. The test shall consist of a data transmission with the PRCU, STEP, or equivalent and inspection of the transmitted data against the SSP 52050 formats. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload CCSDS secondary header.

4.3.3.2.2.1.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA FIELD

Verification of the Attached Payload CCSDS data field shall be by test. The test shall consist of a data transmission with the PRCU, STEP, or equivalent and inspection of the transmitted data against the SSP 52050 formats. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload CCSDS data field.

4.3.3.2.2.1.3 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA ATTACHED PAYLOAD APPLICATION PROCESS IDENTIFIER FIELD

NVR

4.3.3.2.2.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA SYSTEMS TIME CODES

4.3.3.2.2.2.1 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA SYSTEMS UNSEGMENTED TIME

Verification of the Attached Payload CCSDS unsegmented time shall be by test. The test shall consist of a data transmission with the PRCU, STEP, or equivalent and inspection of the transmitted data against the SSP 52050 formats. Verification shall be to test with the PRCU, STEP or equivalent, for correct test CCSDS unsegmented time at the UMA.

4.3.3.2.2.2.2 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS DATA SYSTEMS SEGMENTED TIME

NVR

4.3.3.2.3 MIL–STD–1553 LOW RATE DATA LINK

A. Verification of the Attached Payload MIL–STD–1553 LRDL shall be by inspection. Inspection shall be considered successful when it is shown that there is a single MIL–STD–1553 Remote Terminal to the payload unique MIL–STD–1553 bus.

B. Verification of the Attached Payload MIL–STD–1553 LRDL bus address shall be by inspection and test. Inspection shall be considered successful when it is shown that the MIL–STD–1553 Low Rate Data Link (LRDL) in the unique Attached Payload software ICD conforms with SSP 50193. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload data over the MIL–STD–1553 LRDL.

4.3.3.2.3.1 MIL–STD–1553 PROTOCOL

Verification shall be by inspection and test. Inspection shall be considered successful when it is shown that the MIL–STD–1553 protocol conforms with SSP 52050. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload data over the MIL–STD–1553.

4.3.3.2.3.1.1 STANDARD MESSAGES

A. Verification of the Attached Payload standard messages shall be by inspection and test. The inspection shall consist of a review of the CCSDS data packets against paragraph 3.1.3, CCSDS Formats, of SSP 52050. The test shall consist of a data transmission with the PRCU, STEP, or equivalent and inspection of the transmitted data against the SSP 52050 format. Inspection shall be considered successful when it is shown that the CCSDS data packets in the unique Attached Payload software ICD conforms with paragraph 3.1.3, CCSDS Formats, of SSP 52050. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload CCSDS data packets.

B. Verification of the Attached Payload subaddress assignments for standard messages shall be by inspection and test. Inspection shall be considered successful when it is shown that the CCSDS data packets in the unique Attached Payload software ICD conforms with Table 3.2.3.2.1.4–1 of SSP 52050. Tests shall be considered successful when the PRCU, STEP or equivalent correctly receives the Attached Payload CCSDS data packets.

4.3.3.2.3.1.2 COMMANDING

A. Verification of Attached Payload commanding shall be by inspection and test. Inspection shall be considered successful when it is shown that the command in the unique Attached Payload software ICD conforms with SSP 52050 and SSP 57002. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload commanding.

B. Verification of the Attached Payload subaddress assignments for commands shall be by inspection and test. Inspection shall be considered successful when it is shown that the CCSDS data packets in the unique Attached Payload software ICD conforms with Table 3.2.3.2.1.4–1 of SSP 52050. Tests shall be considered successful when the PRCU, STEP, or equivalent correctly receives the Attached Payload CCSDS data packets.

4.3.3.2.3.1.3 HEALTH AND STATUS DATA

A. Verification of the Attached Payload health and status data shall be by analysis. The analysis shall be considered successful when it shows that the requirements of SSP 52050 have been met.

B. Verification of the Attached Payload health and status data field format shall be by inspection. The inspection shall be considered successful when it shows the format is developed in accordance with SSP 57002.

C. Verification of the Attached Payload health and status data response to the payload MDM shall be by test. The test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the health and status data from the Attached Payload.

4.3.3.2.3.1.4 SAFETY DATA

A. Verification of the Attached Payload safety data shall be by test. The test shall consist of a transmission of a Health and Status CCSDS data packets and an inspection of the received data for inclusion of safety data. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receive the safety data from the Attached Payload.

B. Verification of the Attached Payload safety data shall be by test. The test shall consist of a transmission of a Class 2, Class 3, and Class 4 Caution and Warning message and an inspection of the received data against the format of paragraph 3.2.3.5, Health and Status Data, of SSP 52050 and Table A–1, Telemetry Parameter Definition, and Table A–5, Health and Status ISS Processed Data Packets, of SSP 57002. Test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the safety data from the Attached Payload.

4.3.3.2.3.1.4.1 CAUTION AND WARNING

NVR

4.3.3.2.3.1.4.1.1 CLASS 1 – EMERGENCY

NVR

4.3.3.2.3.1.4.1.2 CLASS 2 – WARNING

A. Verification that the Attached Payload formats the C&W word for the listed warning event that could manifest to an emergency condition and automatic safing has safed the event shall be by analysis and test. Analysis of the payload safety hazard reports and payload safety review data shall identify the types of events identified as warnings that are being monitored. The test shall use the STEP, PRCU or equivalent to determine whether or not the C&W word in the Attached Payload's health and status is formatted as a warning for the events identified as warnings. Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a warning for events that are defined as a warning.

B. Verification that the Attached Payload formats the C&W word for the listed warning events that results in the loss of a hazard control and automatic safing has safed the event shall be by analysis and test. Analysis of the payload safety hazard reports and payload safety review data shall identify the types of events identified as warnings that are being monitored. The test shall use the STEP, PRCU or equivalent to determine whether or not the C&W word in the Attached Payload's health and status is formatted as a warning for the events identified as warnings. Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a warning for events that are defined as a warning.

4.3.3.2.3.1.4.1.3 CLASS 3 – CAUTION

A. Verification that the Attached Payload formats the C&W word for the listed caution events that could manifest to an emergency condition and automatic safing has safed the event shall be by analysis and test. Analysis of the payload safety hazard reports and payload safety review data shall identify the types of events identified as cautions that are being monitored.

The test shall use the STEP, PRCU or equivalent to determine whether or not the C&W word in the Attached Payload’s health and status is formatted as a caution for the events identified as cautions. Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a caution for events that are defined as a caution.

B. Verification that the Attached Payload formats the C&W word for the listed caution events that results in the loss of a hazard control and automatic safing has safed the event shall be by analysis and test. Analysis of the payload safety hazard reports and payload safety review data shall identify the types of events identified as cautions that are being monitored. The test shall use the STEP, PRCU, or equivalent to determine whether or not the C&W word in the Attached Payload’s health and status is formatted as a caution for the events identified as cautions. Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a caution for events that are defined as a caution.

4.3.3.2.3.1.4.1.4 CLASS 4 – ADVISORY

A. Verification that Attached Payloads requiring advisories format the C&W word for the listed advisory events that are set primarily for ground monitoring purposes shall be by analysis and test. Analysis of proposed payload advisories shall identify the types of events identified as advisories. The test shall use the STEP, PRCU or equivalent to determine whether or not the C&W word in the Attached Payload’s health and status is formatted as an advisory for the events identified as advisories. Verification shall be considered successful when the analysis show the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as an advisory for events that are defined as an advisory.

B. Verification that Attached Payloads requiring advisories format the C&W word for the listed advisory events that are a data item that most likely will not exist permanently in the telemetry list but should be time tagged and logged for failure isolation, trending, sustaining engineering, etc. shall be by analysis and test. Analysis of proposed payload advisories shall identify the types of events identified as advisories. The test shall use the STEP, PRCU or equivalent to determine whether or not the C&W word in the Attached Payload’s health and status is formatted as an advisory for the events identified as advisories. Verification shall be considered successful when the analysis show the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as an advisory for events that are defined as an advisory.

4.3.3.2.3.1.5 SERVICE REQUESTS

Verification of the Attached Payload service requests shall be by inspection and test. Inspection shall be considered successful when it is shown that the service requests in the unique Attached Payload software ICD conforms with SSP 52050 and SSP 57002. Verification shall be to test with the PRCU, for correct test service requests at the UMA.

4.3.3.2.3.1.6 ANCILLARY DATA

Verification of the Attached Payload ancillary data shall be by inspection and test. Inspection shall be considered successful when it is shown that the ancillary data in the unique Attached Payload software ICD conforms with SSP 52050 and SSP 57002. Verification shall be to test with the PRCU, for correct test ancillary data at the UMA.

4.3.3.2.3.1.7 FILE TRANSFER

Verification of the Attached Payload file transfer shall be by inspection and test. Inspection shall be considered successful when it is shown that the file transfer in the unique Attached Payload software ICD conforms with SSP 52050 and SSP 57002. Verification shall be to test with the PRCU, for correct test file transfer at the UMA.

4.3.3.2.3.1.8 LOW RATE TELEMETRY

Verification of the Attached Payload low rate telemetry shall be by inspection and test. Inspection shall be considered successful when it is shown that the low rate telemetry in the unique Attached Payload software ICD conforms with SSP 52050 and SSP 57002. Verification shall be to test with the PRCU, for correct low rate telemetry at the UMA.

4.3.3.2.3.1.9 DEFINED MODE CODES

NVR

4.3.3.2.3.1.10 IMPLEMENTED MODE CODES

Verification of the Attached Payload implemented mode codes shall be by inspection and test. Inspection shall be considered successful when it is shown that the implemented mode codes in the unique Attached Payload software ICD conforms with SSP 52050 and SSP 57002. Inspection shall be considered successful when it is shown that the implemented mode codes in the unique Attached Payload software ICD conforms with SSP 52050 and SSP 57002. Test shall be considered successful when the PRCU correctly receives the implemented mode codes from the Attached Payload.

4.3.3.2.3.1.11 ILLEGAL COMMANDS

Verification of the Attached Payload illegal commands shall be by test. Verification shall be to test with the PRCU, for correct test of the MIL–STD–1553 illegal commands produced by setting the message error bit in the status word response at the UMA.

4.3.3.2.3.2 MIL–STD–1553 LOW RATE DATA LINK INTERFACE CHARACTERISTICS

4.3.3.2.3.2.1 LOW RATE DATA LINK CONNECTOR/PIN ASSIGNMENTS

Verification of the Attached Payload MIL–STD–1553 bus A connector and pin assignment shall be by inspection and test. Verification shall be by inspection of the UMA MIL–STD–1553 to the unique Attached Payload hardware ICD against SSP 57004. Verification shall be to test with the PRCU, for correct test of the MIL–STD–1553 to receive and execute commands at the UMA with various address assignments. Verification shall be by inspection of the UMA HRDL connector to mate with a test connector SSQ 21635, NATC07T15N4SN.

4.3.3.2.3.2.2 LOW RATE DATA LINK SIGNAL CHARACTERISTICS

A. Verification of the Attached Payload as it connects to MIL–STD–1553 bus A and bus B shall be by test. Verification shall be to test with the PRCU, for correct test of the MIL–STD–1553 signal characteristics at the UMA with a MIL–STD–1553 bus analyzer as specified in MIL–HBK–1553 Handbook.

B. Verification of the Attached Payload MIL–STD–1553 bus A and bus B shall be by test. Verification shall be to test with the PRCU, for correct test of the MIL–STD–1553 signal characteristics at the UMA with a MIL–STD–1553 bus analyzer as specified in MIL–HBK–1553 Handbook.

4.3.3.2.3.2.3 LOW RATE DATA LINK CABLING

A. Verification shall be by inspection of the UMA LRDL cable. Verification shall be considered successful when it is shown that the UMA LRDL cable meets SSQ 21655 or NASA approved equivalent.

B. Verification shall be by inspection of the UMA LRDL cable. Verification shall be considered successful when the cable drawings are shown to require that the LRDL cable(s) cannot exceed 10 feet (30.7 meters).

4.3.3.2.4 HIGH RATE DATA LINK

4.3.3.2.4.1 PAYLOAD TO HIGH RATE FRAME MULTIPLEXER PROTOCOLS

Verification of the Attached Payload HRFM Protocols shall be by inspection and test. Inspection shall be considered successful when it is shown that the Attached Payload complies with SSP 50184. Tests shall be considered successful when the Attached Payload correctly communicates with the payload MDM.

4.3.3.2.4.2 HIGH RATE DATA LINK INTERFACE CHARACTERISTICS

4.3.3.2.4.2.1 PHYSICAL SIGNALING

Verification of the Attached Payload HRDL physical signaling shall be by test and analysis. Verification of the fiber optic transmitted waveform at the fiber optic transmitter component of the Attached Payload shall be by test at the UMA. Verification of the fiber optic receiver fiber optic sensitivity and bus error rate (BER) shall be by test of the fiber optic receiver component of the Attached Payload at the UMA. Verification of the at the UMA fiber optic receiver sensitivity and BER is by analysis. BER is required of the receiver per the ANSI X3.255.1996 test.

4.3.3.2.4.2.2 ENCODING

Verification of the Attached Payload HRDL encoding shall be by inspection and test. Verification shall be by inspection of the UMA HRDL protocol to the unique Attached Payload hardware at the UMA against SSP 50184. Verification shall be to test the UMA with the PRCU, for correct test of the HRDL protocol.

4.3.3.2.4.2.3 SYMBOLS USED IN TESTING

Verification shall be by test in accordance with 4.3.3.2.4.3.1, HRDL transmitted optical powers at the UMA.

4.3.3.2.4.3 HIGH RATE DATA LINK OPTICAL POWER

4.3.3.2.4.3.1 HIGH RATE DATA LINK TRANSMITTED OPTICAL POWER

Verification shall be to test with fiber optic power meter per ANSI X3.255–1996, for correct optical power at the UMA using the Halt symbol. The optical power perturbations from the test setup are not included in the stated power requirement. The perturbations from the test are to be documented. This test shall be considered successful when when the requirement is met or exceeded after the test setup variations are removed from the result.

4.3.3.2.4.3.2 HIGH RATE DATA LINK RECEIVED OPTICAL POWER

Verification shall be to test at the UMA with a calibrated fiber optic source using the Halt symbol at the minimum power. The optical power perturbations from the test setup are not included in the stated power requirement. The perturbations from the test are to be documented. This test shall be considered successful when the requirement is met or exceeded after the test setup variations are removed from the result.

4.3.3.2.4.4 HIGH RATE DATA LINK FIBER OPTIC CABLE

Verification shall be by inspection of the Attached Payload to UMA HRDL cable. Verification shall be considered successful when it is shown that the Attached Payload to UMA HRDL cable meets SSQ 21654 or NASA Attached Payload approved equivalent.

4.3.3.2.4.5 HIGH RATE DATA LINK FIBER OPTIC CABLE BEND RADIUS

Verification shall be by inspection of the Attached Payload to UMA HRDL cable routing, installation and handling procedures. Verification shall be considered successful when the inspection shows that the routing, installation and handling procedures do not cause the cable to be bent in a tighter radius.

4.3.3.2.4.6 HIGH RATE DATA LINK CONNECTORS

Verification shall be by inspection of the Attached Payload to UMA HRDL connector and demonstration of the Attached Payload UMA HRDL connector to mate with a test connector SSQ 21635, NATC07T13N4SN. Verification shall be considered successful when the inspection and demonstration show compliance with 3.3.2.4.6.

4.3.3.2.4.7 HIGH RATE DATA LINK CONNECTOR/PIN ASSIGNMENTS

Verification shall be by inspection of the Attached Payload UMA HRDL connector/pin assignments to the unique Attached Payload hardware ICD against SSP 57004. Verification shall be considered successful when the inspection shows that the connector and pin assignments in accordance with paragraph 3.2.1 of the unique Attached Payload ICD.

4.3.3.2.5 PORTABLE COMPUTER SYSTEM

Verification shall be by analysis. The verification shall be considered successful when the analysis shows that the requirements defined in SSP 57000, paragraph 3.3.8.2 and 3.3.8.2.1 are met.

4.3.4 PASSIVE THERMAL CONTROL INTERFACE REQUIREMENTS

4.3.4.1 PASSIVE THERMAL CONTROL INTERFACE WITH THE INTEGRATED TRUSS SUPPORT S3 PAYLOAD ATTACH SYSTEM AND P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

4.3.4.1.1 PASSIVE THERMAL CONTROL DESIGN REQUIREMENTS FOR PAYLOADS ON THE ITS S3 PAS AND P3 UCCAS

Verification shall be by analysis. Verification shall be considered to be successful when the analysis shows that the Attached Payload passive thermal control analysis is in accordance with the S3 thermal math model in D684–10058–03–01.

4.3.4.1.1.1 TEMPERATURE REQUIREMENT

Verification shall be by analysis. The analysis shall show that the Attached Payload meets all requirements when the S3 PAS and P3 UCCAS interface temperature is between –120 degrees Fahrenheit (F) and +200 degrees F.

Verification shall be considered successful when the analysis shows the requirements have been met.

4.3.4.1.1.2 DELETED

4.3.4.1.1.3 DELETED

4.3.4.1.1.4 DELETED

4.3.4.1.1.5 THERMAL RADIATION MODELS

A. Verification shall be considered complete when the simplified thermal models of the Attached Payloads are provided to the ISS Program.

B. Verification shall be by analysis. The verification shall be considered successful when analysis shows that the Attached Payload simplified thermal models identify all surfaces over 10% specular and that specularity values are provided for those surfaces.

4.3.4.1.1.6 THERMAL EXCHANGE BETWEEN PAYLOADS

A. Verification shall be by analysis. Verification shall be considered successful when analysis of the Attached Payload geometry shows that no active radiation surfaces have a cumulative view factor greater than 0.1 to any surface of the generic attached payload operational envelope as defined in Figure 3.1.3.1.1.1–1 placed on any other S3 or P3 attach site or when an integrated analysis determines that active radiation surfaces of the Attached Payload do not adversely affect the operation of other Attached Payloads.

B. Verification shall be by analysis or test. Verification shall be considered successful when analysis or test of surface properties shows that Attached Payload surfaces with a view to other Attached Payloads have a specularity of 10% or less or when an integrated analysis determines that specular surfaces of the Attached Payload do not adversely affect the operation of other Attached Payloads.

4.3.5 ENVIRONMENT INTERFACE REQUIREMENTS

4.3.5.1 ENVIRONMENT CONTROL INTERFACE WITH THE ITS S3 PAYLOAD ATTACH SYSTEM AND P3 UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM

4.3.5.1.1 PRESSURE

NVR

4.3.5.1.2 THERMAL ENVIRONMENT

NVR

4.3.5.1.3 HUMIDITY

NVR

4.3.5.1.4 ATOMIC OXYGEN

NVR

4.3.5.1.5 EXTERNAL CONTAMINATION REQUIREMENTS

NVR

4.3.5.1.5.1 MOLECULAR COLUMN DENSITY FROM VENTING, LEAKAGE AND OUTGASSING

An analysis shall be performed using Attached Payload design data and operational conditions to determine molecular column densities for individual species. Verification shall be considered successful when the analysis shows that the molecular column densities produced by the Attached Payload do no exceed 1 x 10^{+14} molecules/cm^2 for any individual species, when viewed from any other Attached Payload location. The vent axis will be oriented to preclude direct plume impingement on other Attached Payloads.

4.3.5.1.5.2 MOLECULAR DEPOSITION FROM MATERIALS OUTGASSING AND VENTING

A. Outgassing testing shall be performed of the Attached Payload component materials exposed to space vacuum and one used in quantities greater than 0.1 m^2 surface area per guidelines established in ASTM E 1559. The test shall be of long duration (144 hours minimum). The materials samples (emitters) shall be tested at their nominal operating temperature. During the ASTM E 1559 testing, one QCM will be maintained at –40°C; one QCM will be maintained at +25°C; and one QCM will be maintained at a temperature between –40°C and +25°C. Verification shall be considered successful when the Attached Payload demonstrates by analysis that cumulative contaminant deposits do not exceed $1x10^{-14}$ gm/cm^2/sec on other Attached Payloads.

B. Outgassing testing shall be performed of the Attached Payload component materials exposed to space vacuum and are used in quantities greater than 0.1 m^2 surface area per guidelines established in ASTM E 1559. The test shall be of long duration (144 hours minimum). The materials samples (emitters) shall be tested at their nominal operating temperature. During the ASTM E 1559 testing, one QCM will be maintained at –40°C; one QCM will be maintained at +25°C; and one QCM will be maintained at a tempeature between –40°C and +25°C. Verification shall be considered successful when the Attached Payload demonstrates by analysis that cumulative contaminant deposits do not exceed $1x10^{-15}$ gm/cm^2/sec on ISS element external contamination sensitive surfaces.

4.3.5.1.5.3 PARTICULATES

Verification of limitation of particulate dispersal by active venting shall be by analysis and/or inspection. The analysis and/or inspection of drawings shall verify that gases containing particulates greater than 100 microns are not actively vented from the attached payload. The verification shall be considered successful when the analysis and/or inspection of drawings show that the attached payload design does not release particulates greater than 100 microns in size.

4.3.5.1.6 ELECTROMAGNETIC RADIATION

NVR

4.3.5.1.7 PLASMA

NVR

4.3.5.1.8 IONIZING RADIATION

4.3.5.1.8.1 ATTACHED PAYLOADS CONTAINED OR GENERATED IONIZING RADIATION

Verification that Attached Payloads containing or using radioactive materials or generating ionizing radiation meet the requirements of 1700.7 ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.5.1.8.2 IONIZING RADIATION DOSE

Verification that equipment and subsystems are designed to not produce an unsafe condition or one that could cause damage to equipment external to the payload as a result of exposure to ionizing radiation shall be by analysis. An analysis of equipment and subsystems shall be performed using the operational lifetime and parts characterization data to assure that the design meets the requirement when exposed to ionizing radiation. The verification shall be considered successful when the analysis shows that the Attached Payload equipment and subsystems will not produce an unsafe condition or one that could cause damage to equipment external to the payload when exposed as specified in SSP 30512, table 3.1.2.

4.3.5.1.8.3 NOMINAL SINGLE EVENT EFFECTS IONIZING RADIATION

Verification that equipment and subsystems are designed to not produce an unsafe condition or one that could cause damage to equipment external to the payload as a result of exposure to SEE ionizing radiation shall be by analysis. An analysis of equipment and subsystems shall be performed using the operational lifetime and parts characterization data to assure that the design meets the requirement when exposed to SEE ionizing radiation. The verification shall be considered successful when the analysis shows that the Attached Payload equipment and subsystems will not produce an unsafe condition or one that could cause damage to Attached Payload equipment external to the payload when exposed to the specified environment.

4.3.5.1.8.4 EXTREME SINGLE EVENT EFFECTS

Verification that equipment and subsystems are designed to not produce an unsafe condition or one that could cause damage to equipment external to the payload as a result of exposure to extreme SEE ionizing radiation shall be by analysis. An analysis of equipment and subsystems shall be performed using the operational lifetime and parts characterization data to assure that the design meets the requirement when exposed to extreme SEE ionizing radiation. The verification shall be considered successful when the analysis shows that the Attached Payload equipment and subsystems will not produce an unsafe condition or one that could cause damage to equipment external to the payload when exposed to the specified environment.

4.3.5.1.9 SOLAR ULTRAVIOLET RADIATION

NVR

4.3.5.1.10 PLUME IMPINGEMENT

NVR

4.3.5.1.11 METEOROID AND ORBITAL DEBRIS

NVR

4.3.5.1.12 ACCELERATION ENVIRONMENT

A. An analysis shall be performed to verify that the Attached Payload will withstand on–orbit accelerations as defined in paragraph 3.5.1.12.A. This analysis shall be based on lower level component qualification data as well as test verification of Attached Payload primary structure to equivalent static loads equal to or greater than the specified on–orbit environment. The verification shall be considered successful when the analysis shows that the Attached Payload design will withstand specified on–orbit accelerations and loads.

B. An analysis shall be performed to verify that the Attached Payload will withstand on–orbit accelerations during berthing of the Attached Payload as defined in paragraph 3.5.1.12.CB. This analysis shall be based on lower level component qualification data as well as test verification of Attached Payload primary structure to equivalent static loads equal to or greater than the specified on–orbit environment. The verification shall be considered successful when the analysis shows that the Attached Payload design will withstand specified on–orbit accelerations and loads.

4.3.5.1.13 VIBRATION ENVIRONMENT

An analysis shall be performed to show that Attached Payload operating equipment shall withstand the specified on–orbit linear peak vibration environment. The analysis shall be based on component tests. The verification shall be considered successful when the analysis shows that the operating equipment can withstand the requirement as specified.

4.3.6 MATERIALS AND PARTS INTERFACE REQUIREMENTS

4.3.6.1 MATERIALS AND PARTS USE AND SELECTION

Analysis shall be conducted to verify NSTS 1700.7 ISS Addendum requirements have been met by inspection of Attached Payload drawings. Analysis shall be conducted to verify NSTS 1700.7 ISS Addendum requirements have been met by inspection of Attached Payload drawings. Verification shall be considered successful when the MSFC and/or JSC Materials Analysis and Evaluation Boards (or equivalent) approved the selection and use of all materials comprising the Attached Payload. The Attached Payload developer will be required to provide this approval to the PSRP in order to close associated Payload Safety Hazard Reports.

4.3.6.1.1 THERMAL VACUUM STABILITY

Verification that Attached Payload non–metallic materials are tested per ASTM–E595 shall be by inspection. The verification shall be considered successful when the payload developer certifies that all non–metallic materials have a Total Mass Loss of <1.0 percent and a volatile condensable material of <0.1 percent when tested per ASTM–E595 or have obtained approval from the cognizant NASA materials organization for usage of materials not meeting the specified criteria in the intended use application.

4.3.6.2 COMMERCIAL PARTS

Verification that COTS parts meet the requirements of NSTS 1700.7 ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when COTS parts are shown to meet the requirements of NSTS 1700.7 ISS Addendum.

4.3.6.3 CLEANLINESS

Verification that Attached Payload hardware external surfaces conform to visibly clean–standard cleanliness requirements as specified in SN–C–0005, NSTS Contamination Control Requirements Manual shall be by inspection. An inspection of the hardware as specified in SN–C–0005 shall be performed to show that the Attached Payload hardware meets the visibly clean–standard requirement. Verification shall be considered successful when the inspection shows the Attached Payload hardware external surfaces meets the requirements for visibly clean–standard specified in SN–C–0005.

4.3.6.4 ATOMIC OXYGEN INTERACTION

Verification shall be by inspection. Verification shall be considered successful when a drawing inspection shows that no silver plated hardware is used.

4.3.7 EXTRAVEHICULAR ROBOTICS REQUIREMENTS

4.3.7.1 EQUIPMENT REQUIRING SHUTTLE ROBOTIC SUPPORT

A. NVR

B. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

C. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

D. This requirement shall be verified by inspection of flight drawings in the unique Attached Payload hardware ICD. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

E. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

F. NVR

G. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

H. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

I. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified

J. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

K. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirements as specified.

L. NVR

M. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

N. This requirement shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows compliance with the requirements as specified.

4.3.7.2 EXTERNAL EQUIPMENT REQUIRING ROBOTIC HAND–OFF

This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

4.3.7.3 EXTERNAL EQUIPMENT REQUIRING SPACE STATION REMOTE MANIPULATOR SYSTEM SUPPORT

A. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

B. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

C. NVR

D. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

E. This requirement shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows compliance with the requirements as specified.

F. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

G. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

H. NVR

I. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

J. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

K. This requirement shall be verified by inspection of flight drawings in the unique Attached Payload hardware ICD. The verification shall be considered successful when the inspection shows compliance with the requirements as specified.

4.3.7.3.1 EQUIPMENT REQUIRING SPACE STATION REMOTE MANIPULATOR SYSTEM SUPPORT USING AN NATIONAL SPACE TRANSPORTATION SYSTEM GRAPPLE FIXTURE

A. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

B. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

C. NVR

D. NVR

E. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirements as specified.

F. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirements as specified.

G. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirements as specified.

4.3.7.3.2 EQUIPMENT REQUIRING SPACE STATION REMOTE MANIPULATOR SYSTEM SUPPORT USING A POWER DATA GRAPPLE FIXTURE

A. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

B. This requirement shall be verified by inspection of flight drawings and analysis. The verification shall be considered successful when the inspection and analysis shows compliance with the requirement as specified.

C. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

D. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

E. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

F. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

G. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

H. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

I. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

4.3.7.3.3 EQUIPMENT REQUIRING SPACE STATION REMOTE MANIPULATOR SYSTEM SUPPORT USING A POWER VIDEO GRAPPLE FIXTURE (PVGF)

A. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

B. This requirement shall be verified by inspection of flight drawings and analysis. The verification shall be considered successful when the inspection and analysis shows compliance with the requirement as specified.

C. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

D. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

E. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

F. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

G. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

H. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

I. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows compliance with the requirement as specified.

4.3.7.4 EXTERNAL EQUIPMENT REQUIRING DEXTEROUS ROBOTIC SUPPORT

A. This requirement shall be verified by inspection and analysis. The verification shall be considered successful when the inspection and analysis show compliance with the requirement as specified.

B. An analysis and inspection of flight element drawings shall be performed to verify that dexterous external equipment is as specified. A mass properties analysis shall be performed to verify the mass properties requirement, an inspection of flight element drawings shall be performed to verify the volume constraint, and a structural analysis shall be performed to verify the frequency requirement. The verification shall be considered successful when the inspection and analysis show compliance with the requirement as specified.

C. The equipment requiring dexterous robot support shall be verified by analysis. The analysis shall consist of analyzing verification data to show compliance with SSP 30550, Volume 1, paragraphs 4.3.2.1.5, 4.3.2.2.4, 4.3.4.1.1 (excluding 4.3.4.1.1.5 and 4.3.4.1.1.6), 4.3.4.2.1.4, 4.3.4.2.1.5, 4.3.4.2.2 (excluding 4.3.4.2.2.1.3, 4.3.4.2.2.1.8, 4.3.4.2.2.1.10, 4.3.4.2.2.4, and 4.3.4.2.2.5), 4.3.4.3, 4.3.4.4.1.5, 4.3.4.4.1.6, 4.3.4.6, 4.3.4.7.2.1, 4.3.4.8.1.1.3, 4.3.4.9.2.1, 4.3.4.9.2.5, 4.3.4.9.2.6, 4.3.4.13, 4.3.4.15, 4.3.5.3.1, and 4.3.5.3.2. The verification shall be considered successful when the analysis shows the equipment meets the requirements as specified.

D. The worksites associated with the equipment that requires dexterous robotics support shall be verified by analysis. The analysis shall consist of analyzing verification data to show compliance with SSP 30550, Volume 1, paragraphs 4.3.3.1.1, 4.3.3.1.4, 4.3.3.1.5, 4.3.3.3.3, 4.3.3.3.5, 4.3.4.10.1.2, and 4.3.4.10.1.4. The verification shall be considered successful when the analysis shows the equipment meets the requirements as specified.

E. An inspection of flight element drawings shall be performed to verify that the equipment requiring temporary storage on the dexterous robot is as specified. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

4.3.7.5 EQUIPMENT REQUIRING ROBOTIC TRANSLATION

A. This requirement shall be verified by analysis and inspection. A mass property analysis shall be used to verify the mass, inertia, and CG offset. Inspection of flight element drawings shall be used to verify the diameter and length. Structural analysis shall be used to verify the minimum frequency. The verification shall be considered successful when the mass property analysis, inspection of flight element drawings, and structural analysis all show compliance with the requirement as specified.

B. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows that the distance between the SSRMS GF and the POA GF does not exceed the requirement as specified.

C. This requirement shall be verified by inspection of flight drawings. The verification shall be considered successful when the inspection shows compliance with the requirement as specified.

D. Verification shall be by analysis. The verification shall be considered successful when the analysis shows the Attached Payload does not extend beyond the robotics translation corridor specified in SSP 41162, paragraph 3.2.2.7.

4.3.7.6 EXTERNAL BERTHING CAMERA SYSTEM

NVR

4.3.7.6.1 EBCS AVIONICS PACKAGE ENVELOPE AND MOUNTING

A. Verification shall be by inspection of design drawings. Verification shall be considered successful when the inspection shows that the payload has accommodated and does not obstruct the optical keep–out zone as defined in Figures 3.7.6.1–1 and 3.7.6.1–2.

B. Verification shall be by inspection of design drawings and analysis. Verification shall be considered successful when the inspection and analysis show that the EBCS Avionics Package is located as defined in Figure 3.7.6–1 and paragraph 3.7.6.1.B, and mechanically interfaces with the payload in accordance with paragraph 3.7.1–1 of the unique payload ICD, respectively.

C. Verification shall be by analysis. Verification shall be considered successful when an analysis shows that the EBCS Avionics Package mounting surface provided by the payload maintains the EBCS mounting location as specified in 3.7.6.1.B after exposure to vibration and impact loads and during exposure to the on–orbit thermal environment.

4.3.7.6.2 EBCS AVIONICS PACKAGE POWER

A. Verification shall be by inspection of design drawings and demonstration. Verification shall be considered successful when the inspection shows that the payload has routed the PVGF cable to the EBCS Avionics Package connectors as specified in paragraph 3.7.6.2 and a demonstration indicates that power is available from the PVGF cable.

B. Verification shall be by inspection of design drawings and demonstration. Verification shall be considered successful when the inspection shows that two heater busses are provided to the EBCS Avionics Package and when demonstration shows that the required keep–alive heater power is available from each heater bus.

4.3.7.6.3 EBCS THERMAL REQUIREMENTS

A. **(TBD #16)**

B. **(TBD #16)**

4.3.7.6.4 EBCS VIBRATION REQUIREMENT

Verification shall be by analysis. Verification shall be considered successful when the analysis shows that the EBCS vibration limits, as defined in Table 3.7.6.4–1, have not been exceeded.

4.3.7.6.5 EBCS AVIONICS PACKAGE VIDEO

Verification shall be by inspection of design drawings and demonstration. Verification shall be considered successful when the inspection shows that the payload has routed the PVGF cable to the EBCS Avionics Package connectors as specified in paragraph 3.7.6.5 and a demonstration indicates that the required video and synchronization signals are available from the PVGF, via the PVGF cable.

4.3.8 EXTRAVEHICULAR ACTIVITY

A. EVA contingency operations shall be verified by analysis, demonstration and inspection. Verification will be considered successful when the analysis, demonstration and inspection confirms all EVA contingency activity performed at the end of the SSRMS or from existing ISS worksites, is in accordance with NSTS 07700, Volume XIV, Appendix 7.

B. Verification shall be by analysis and inspection. Verification will be considered successful when the analysis and inspection confirm that the design is in accordance with NSTS 07700, Volume XIV, Appendix 7.

4.3.8.1 EXTRAVEHICULAR ACTIVITY AS A BACKUP FOR ROBOTICS ACTIVITIES

An analysis of Attached Payload flight drawings shall be used to verify that manual EVA backup provisions have been provided in accordance with SSP 50005, paragraph 12.3. Verification shall be successful when the analysis shows compliance with the requirements in 3.8.1 A, B and C.

4.3.8.2 EXTRAVEHICULAR ACTIVITY TRANSLATION

Verification shall be by analysis. The analysis shall be based on documentation defining the Attached Payload on–orbit configuration and EVA contingency operations analysis. The verification shall be considered successful when the analysis shows that EVA translation paths on Attached Payloads exist only for the purpose of removing the SSRMS from a grapple fixture.

4.3.8.2.1 PAYLOAD ATTACH SYSTEM/UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM INTERFACE CLEARANCES

An inspection of the design and installation drawings shall be performed to verify that the Attached Payloads do not violate the EVA access envelopes as defined by par. 3.1.3.1.1.3.A. Verification shall be considered successful when the inspection confirms that the EVA access envelopes are not violated.

4.3.8.2.2 EXTRAVEHICULAR ACTIVITY TRANSLATION CORRIDOR PROTRUSION

Verification shall be by analysis and inspection. The inspection shall be based on models and drawings of the on orbit PAS/UCCAS installed Attached Payload. An analysis shall be performed to ensure that in the event of a translation corridor protrusion, appropriate fixtures are provided to maintain intended function. The verification shall be considered successful when the on orbit installed Attached Payload configuration allows for EVA translation in accordance with SSP 50005.

4.3.8.3 HUMAN ENGINEERING DESIGN

4.3.8.3.1 CREW ACCESS DIMENSIONS

Payload hardware accessibility shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the specified accessibility is sufficient to remove, replace, operate and maintain integrated Attached Payload equipment.

4.3.8.3.1.1 BODY ENVELOPE AND REACH ACCESSIBILITY

Adequate volume shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the specified volume to accommodate crew performance of tasks including tool utilization is sufficient to remove, replace, operate and maintain the integrated Attached Payload equipment.

4.3.8.3.1.1.1 CENTERING

A. Handrail/handhold locations to the left or right of the body centerline shall be verified by analysis. The analysis shall be based upon 50th percentile American female to 95th percentile American male anthropometric measurements and Attached Payload flight drawings. The analysis shall be considered successful when the Attached Payload flight drawings show that there is a handrail/handhold provided less than 24 inches to the left or right of the body centerline when working in a foot restraint position.

B. Handrail/handhold locations above or below the center or the crewmembers optimum two–handed work envelope shall be verified by analysis. The analysis shall be based upon 50th percentile American female to 95th percentile American male anthropometric measurements and Attached Payload flight drawings. The analysis shall be considered successful when the Attached Payload flight drawings show that analysis shall be considered successful when the Attached Payload flight drawings show that there is a handrail/handhold provided less than 18 inches above or below the center when working in a foot restraint position.

4.3.8.3.1.1.2 EXTRAVEHICULAR ACTIVITY CREWMEMBER FIELD OF VIEW

The visual task location requirements shall be verified by analysis. The analysis shall be based upon documentation defining EVA tasks required at Attached Payload and flight element drawings. The analysis shall show that the equipment, controls, displays, and markings are positioned so that a crewmember in an EMU can see them while performing the task. The analysis shall be considered successful when the data shows that the equipment, controls, displays, and markings required to perform EVA tasks are located within the field of view defined in Figure 3.8.3.1.1.2–1.

4.3.8.3.1.1.3 EXTERNAL TASK LOCATION REQUIREMENTS

All pressurized suit task locations shall be verified by demonstration. Verification shall be considered successful when the demonstration shows that the specified EVA tasks are located per Figure 3.8.3.1.1.3–1.

4.3.8.3.2 STRENGTH REQUIREMENTS

4.3.8.3.2.1 EXTERNAL LIMIT LOADS

External hardware with crew or crew actuated tool interface shall be verified by thermal vacuum test. The test shall consist of measuring the forces required to actuate the hardware. The test shall be considered successful when the data shows that the actuation forces for crew or crew actuated tool interfaces are in accordance with Table 3.1.1.2.6–2 under the full range of thermal and vacuum conditions expected on–orbit.

4.3.8.3.2.2 EXTRAVEHICULAR ACTIVITY ACTUATED CONTROLS

Verification shall be by inspection of Attached Payload drawings. Verification will be successful when it has shown that there are no EVA actuated controls on Attached Payloads.

4.3.8.3.3 MOBILITY AIDS AND RESTRAINTS

Verification shall be by inspection. Inspection of Attached Payload drawings shall include mobility aids and restraints. Verification shall be considered successful when the Attached Payload is in accordance with the requirements specified in SSP 50005, paragraph 11.8.

4.3.8.3.3.1 PROVIDE EXTRAVEHICULAR ACTIVITY HANDLES

Provision of handles on portable payload units shall be verified by inspection of equipment drawings. Verification shall be considered successful when inspection of the portable unit hardware confirms compliance with the requirements.

4.3.8.3.3.1.1 EXTRAVEHICULAR ACTIVITY HANDHOLDS/HANDRAILS

A. Handhold/handrail design shall be verified by analysis. The analysis shall be considered successful when the Attached Payload flight drawings show that the design is in accordance with SSP 30256:001, paragraph 3.6.1.

B. Handrail/handhold orientation shall be verified by analysis. The analysis shall be considered successful when the Attached Payload flight drawings show that handrail/handholds are provided in accordance to 3.8.3.3.1.1.

4.3.8.3.3.1.2 DIMENSIONS

EVA handle dimensions for moveable or portable units shall be verified by analysis or demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirements in 3.8.3.3.1.2.

4.3.8.3.3.1.3 MOUNTED CLEARANCE

A. EVA clearances between the low surface of the handrail/handhold and the mounting surface shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration of the flight hardware confirms compliance with the requirements in 3.8.3.3.1.3 A.

B. An analysis or demonstration of the flight hardware shall be performed to verify this requirement. The verification shall be considered successful when the analysis or demonstration confirms compliance with the requirement specified in 3.8.3.3.1.3 B.

C. EVA clearances consistent with gloved hand sizes shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration of the flight hardware confirms compliance with the requirements in 3.8.3.3.1.3 C.

4.3.8.3.3.1.4 POSITIONING/LOCATION

A. An analysis or demonstration of the flight hardware shall be performed to verify this requirement. The verification shall be considered successful when the analysis or demonstration confirms compliance with the requirement specified in 3.8.3.3.1.4 A.

B. An analysis or demonstration of the flight hardware shall be performed to verify this requirement. The verification shall be considered successful when the analysis or demonstration confirms that the handles and grasp areas are placed on the accessible surface of an item consistent with the removal direction in compliance with the requirement specified in 3.8.3.3.1.4 B.

C. An analysis or demonstration of the flight hardware shall be performed to verify this requirement. The verification shall be considered successful when the analysis or demonstration confirms compliance with the requirement specified in 3.8.3.3.1.4 C.

4.3.8.3.3.1.5 NON–FIXED HANDLES DESIGN

A. An analysis or demonstration of the flight hardware shall be performed to verify this requirement. The verification shall be considered successful when the analysis or demonstration confirms that the stop position for holding the handle perpendicular to the surface on which it is mounted is in compliance with the requirement specified in 3.8.3.3.1.5 A.

B. An analysis or demonstration of the flight hardware shall be performed to verify this requirement. The verification shall be considered successful when the analysis or demonstration confirms that the flight hardware is in compliance with the requirement specified in 3.8.3.3.1.5 B.

C. An analysis or demonstration of the flight hardware shall be performed to verify this requirement. The verification shall be considered successful when the analysis or demonstration confirms that the handles incorporate tactile and/or visual indication of locked/unlocked status in compliance with the requirement specified in 3.8.3.3.1.5 C.

4.3.8.3.3.1.6 HANDRAIL/HANDHOLD TETHER ATTACHMENT

An inspection of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the inspection shows that EVA handrails/handholds accommodate safety tether hooks as specified.

4.3.8.3.3.1.7 DANGER WARNINGS

An inspection of Attached Payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the inspections shows that translation and mobility handholds located within three ft. of payload equipment which poses a critical or catastrophic hazard to the crewmember or to the equipment, are identified and color coded.

An analysis of Attached Payload flight drawings shall be used to verify that manual EVA backup provisions have been provided in accordance with SSP 50005, paragraph 12.3.

4.3.8.3.3.1.8 COLOR

An inspection of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the inspection shows all EVA handrails/handholds and safety tether points are yellow.

4.3.8.3.3.2 EXTRAVEHICULAR ACTIVITY SAFETY TETHERS AND SAFETY HOOKS

An inspection of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the inspection shows that crew safety tether points have been provided along all routes and at all worksites.

4.3.8.3.3.2.1 TETHER ATTACHMENT POINTS

A. An inspection of Attached Payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the inspection shows that crew safety tether points have been provided in accordance with 3.8.3.3.2.1.

B. An inspection of Attached Payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the inspection shows that crew safety tether points have been provided on the interfacing surface which the item is to be secured in accordance with 3.8.3.3.2.1.

C. An inspection of Attached Payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the inspection shows that crew safety tether points have been designed in accordance with 3.8.3.3.2.1.

4.3.8.3.4 GLOVED OPERATION

4.3.8.3.4.1 EXTRAVEHICULAR ACTIVITY GLOVED HAND ACCESS

Verification shall be by analysis or demonstration of design. Equipment drawings for items that require gloved hand operations shall be analyzed to verify clearance in accordance with Figure 3.8.3.4.1–1. Verification shall be considered successful when dimensional analysis or demonstration of the design shows compliance with the specified requirement.

4.3.8.3.5 LOCATION CODING

The Attached Payload location coding scheme shall be analyzed to verify that it is a single, consistent alphanumeric operational coding standard for designating locations across the module in accordance with SSP 30575. The verification shall be considered successful when it is shown that there is a single, consistent operational coding standard in accordance with SSP 30575.

4.3.8.4 HUMAN ENGINEERING SAFETY

4.3.8.4.1 EXTERNAL TOUCH TEMPERATURE

4.3.8.4.1.1 INCIDENTAL CONTACT

An analysis shall be performed using data from drawings, thermal analyses, tests, and operational procedures to identify hardware whose temperature exceed – 180 degrees F to +235 degrees F and have potential for incidental contact by EVA crewmembers. The analysis shall determine contact surface temperatures and average heat transfer rates at EVA interfaces. For the purposes of this analysis, a boundary node with the appropriate temperature listed in Table 3.8.4.1.1–1 is connected with linear conductor to a 42.75 in squared surface of the objects exposed area overlaying the contact node. The contact node, an adiabatic surface except for contact with the boundary node, shall have a surface area of 42.75 in squared and shall have a non–zero thermal capacitance value. Analysis shall show that heat transfer rates do not exceed rates specified in Table 3.8.4.1.1–1. Verification shall be considered successful when the analysis shows that equipment temperatures and heat rates shall not pose a hazard to the suited EVA crewmember.

4.3.8.4.1.2 UNLIMITED CONTACT

An analysis shall be performed using data from drawings, thermal analyses, tests, and operational procedures to identify hardware whose temperature exceed –45 degrees F to + 145 degrees F for potential unlimited contact by EVA crewmembers. The analysis shall determine contact surface temperatures and average heat transfer rates at EVA interfaces. For the purposes of this analysis, a boundary node with the appropriate temperature listed in Table 3.8.4.1.2–1 is connected with linear conductor to a 42.75 inches squared surface of the objects exposed area overlaying the contact node. The contact node, an adiabatic surface except for contact with the boundary node, shall have a surface area of 42.75 inches squared and shall have a non–zero thermal capacitance value. Analysis shall show that heat transfer rates do not exceed rates specified in Table 3.8.4.1.2–1**.** Verification shall be considered successful when the analysis shows that equipment temperatures and heat rates shall not pose a hazard to the suited EVA crewmember.

4.3.8.4.2 EQUIPMENT CLEARANCE FOR ENTRAPMENT HAZARDS

Verification shall be by analysis and demonstration. An analysis shall be performed using data from drawings, operational procedures, and integration documentation to identify equipment/hardware that may require removal or replacement or both and the planned stowage associated with maintenance operations. Demonstrations shall show that stowage capacity and locations for equipment/hardware used in the maintenance procedures are sufficient to prevent the creation of a crew entrapment hazard. Verification shall be considered successful when demonstrations show that maintenance activities will not require stowage of material in a manner that obstructs crewmember translation or creates an entrapment area.

4.3.8.4.2.1 EXTERNAL CORNER AND EDGE PROTECTION

4.3.8.4.2.1.1 SHARP EDGES

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify hardware edges and corners requiring rounding, the use of guards, or covers due to location in crewmember translation paths and maintenance worksites. A drawing inspection shall show that the required edge and corner rounding, deburring, or cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when inspection of the hardware shows that all required edges or corners have been properly machined, covered, or guarded. The verification shall be successful when the demonstration verifies that the exposed corners and edges do not pose a hazard to the EVA crew.

4.3.8.4.2.1.1.1 EXPOSED EDGE REQUIREMENTS

A. Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation and operational procedures notes to identify exposed edges requiring rounding. A drawing inspection shall show that the design drawing notes for rounding exposed edges of 0.25 in. (6.4 mm) thick or greater are in accordance with specified requirements. Verification shall be considered successful when the inspection of the hardware shows that the hardware meets the specified requirement in 3.8.4.2.1.1.1 A.

B. Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation and operational procedures notes to identify exposed edges requiring rounding. A drawing inspection shall show that the design drawing notes for rounding exposed edges of 0.12 to 0.25 in. (3.0 to 6.4 mm) thick are in accordance with specified requirements. Verification shall be considered successful when the inspection of the hardware shows that the hardware meets the specified requirement in 3.8.4.2.1.1.1 B.

C. Verification shall be analysis and inspection. An analysis shall be performed using data from drawings, integration documentation and operational procedures notes to identify exposed edges requiring rounding. A drawing inspection shall show that the design drawing notes for rounding exposed edges of 0.02 to 0.12 in. (0.5 to 3.0 mm) thick are in accordance with specified requirements. Verification shall be considered successful when the inspection of the hardware shows that the hardware meets the specified requirement in 3.8.4.2.1.1.1 C.

D. Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation and operational procedures notes to identify exposed edges requiring rolling and curling. A drawing inspection shall show that the design drawing notes for rolling and curling exposed edges of 0.02 in. (0.5 mm) thick or less are in accordance with specified requirements. Verification shall be considered successful when the inspection of the hardware shows that the hardware meets the specified requirement in 3.8.4.2.1.1.1D.

4.3.8.4.2.1.1.2 EXPOSED CORNER REQUIREMENTS

A. Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation and operational procedures notes to identify exposed corners requiring rounding. A drawing inspection shall show that the design drawing notes for rounding exposed corners of less than 1.0 in. (25 mm) thick are in accordance with specified requirements. Verification shall be considered successful when the inspection of the hardware shows that the hardware meets the specified requirement in 3.8.4.2.1.1.2 A.

B. Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation and operational procedures notes to identify exposed corners requiring rounding. A drawing inspection shall show that the design drawing notes for rounding exposed corners of greater than 1.0 in. (25 mm) thick are in accordance with specified requirements. Verification shall be considered successful when the inspection of the hardware show that the hardware meets the specified requirement in 3.8.4.2.1.1.2 B.

4.3.8.4.2.1.2 THIN MATERIALS

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify hardware material less than an 0.08 inches thick. A drawing inspection shall show that the required edge radii has been accomplished or proper guards are in place. Verification shall be considered successful when inspection of the hardware shows that all required edges have been properly machined.

4.3.8.4.2.2 BURRS

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify all potential areas of burrs and the required use of procedures to identify and deburr surfaces due to location in crewmember translation paths and maintenance worksites. A drawing inspection shall show that deburring is required. Verification shall be considered successful when analysis and inspection shows that all edges have been properly deburred.

4.3.8.4.2.3 HOLES

Verification shall be by inspection. A drawing inspection shall assure that holes (round or slotted) 0.4 to 1.0 inches are covered. Verification shall be considered successful when inspection shows that holes in the range of 0.4 to 1.0 inches are covered.

4.3.8.4.2.3.1 HANDRAIL/HOLDS

Verification shall be by inspection. A drawing inspection shall assure that holes (round, slotted, polygonal) in EVA translation handrails/holds are 1.0 inches in diameter. Verification shall be considered successful when inspection shows that holes in EVA translation handrails/holds are 1.0 inches or greater in diameter.

4.3.8.4.2.4 PINCH POINTS

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify hardware pinch points and the required use of guards or covers due to location in crewmember translation paths and maintenance worksites. A drawing inspection shall show that the required cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when the analysis and inspection show that all potential pinch points have been properly covered, or guarded.

4.3.8.4.2.5 PROTECTIVE COVERS FOR PORTABLE EQUIPMENT

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify the required use of guards or protective covers for portable equipment. A drawing inspection shall show that the required cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that all necessary items have been properly covered or guarded.

4.3.8.4.2.6 LATCHES

4.3.8.4.2.6.1 DESIGN

A. Verification shall be by analysis of design. The analysis shall verify that latching devices are designed in a manner to preclude the entrapment of appendages. Verification shall be considered successful when the analysis shows that the Attached Payload meets the specified requirement.

B. Verification shall be by analysis of design. The analysis shall verify that latching devices are covered in a manner that does not allow gaps or overhangs that can catch fabrics or pressure suit appendages, or are designed in a manner to preclude the catching of fabrics and pressure suit appendages. Verification shall be considered successful when the analysis shows that the Attached Payload meets the specified requirement.

C. Verification shall be by analysis of design. The analysis shall verify that over center latching devices are designed in a manner to preclude the undesirable latch element realignment, interference or reengagement. Verification shall be considered successful when the analysis shows that the Attached Payload meets the specified requirement.

D. Verification shall be by analysis of design. The analysis shall verify that latching devices are designed to provide locking features. Verification shall be considered successful when the analysis shows that the Attached Payload meets the specified requirement.

E. Verification shall be by analysis of design. The analysis shall verify that latching devices with a handle are designed in a manner to be operable by one hand. Verification shall be considered successful when the analysis shows that the Attached Payload meets the specified requirement.

4.3.8.4.2.6.2 PROTECTIVE COVERS OR GUARDS

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify latches and similar devices and the required use of guards or covers due to location in crewmember translation paths and maintenance worksites. A drawing inspection shall show that the required cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that all latches and similar devices have been properly covered, or guarded.

4.3.8.4.2.7 CAPTIVE PARTS

Verification shall be by demonstration. The demonstration shall show that unrestrained parts that may be temporarily removed on orbit will be held captive. Verification shall be considered successful it has been demonstrated that all unrestrained parts that may be temporarily removed on orbit are tethered or otherwise held captive.

4.3.8.4.2.7.1 SCREWS AND BOLTS

An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify screws and bolts which exceed the length specified in 3.8.4.2.7.1 and the required use of guards or covers due to location in crewmember translation paths and maintenance worksites. A drawing inspection shall show that the required cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that screws and bolts which exceed the specified length have been properly covered, or guarded.

4.3.8.4.2.7.2 SECURING PINS

An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirement has been met.

4.3.8.4.2.7.3 LOCKING WIRES

An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirement has been met in 3.8.4.2.7.3.

4.3.8.4.2.8 SAFETY CRITICAL FASTENERS

A test shall be performed to verify that safety critical fasteners will not back out under all environmental conditions. Verification shall be considered successful when safety critical fasteners will not back out.

4.3.8.4.2.9 LEVERS, CRANKS, HOOKS, AND CONTROLS

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify levers, cranks, hooks and controls and the required use of guards or covers due to location in crewmember translation paths and maintenance worksites. A drawing inspection shall show that the required cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that all levers, cranks, hooks, and controls have been properly covered, or guarded.

4.3.8.4.3 MOVING OR ROTATING EQUIPMENT

An analysis shall be performed using data from drawings, operational procedures, integration documentation, and time lines to identify equipment that is designed to rotate or move, operations that require EVA crewmembers to be in the area of the equipment, scenarios involving direct interface between EVA crewmembers and the equipment, and controls to prevent unwanted equipment movement. Analysis shall be performed to verify that EVA crew is not required to operate or translate near hazardous moving equipment. Verification shall be considered successful when the analysis verifies that it is not necessary for the EVA crewmembers to operate near moving or rotating equipment.

4.3.8.4.4 POWER SOURCES

Verification shall be by analysis. An analysis shall be performed using data from drawings, operational procedures, integration documentation and timelines to identify equipment that is designed to used nuclear power source or radioisotopic generator power source that require EVA crewmembers to be in the area of the equipment and the method for protecting the crewmembers from radiation exposure. Verification shall be considered successful when the analysis verified that the hardware provides the required radiation protection.

4.3.8.4.5 TRANSMITTERS

An analysis shall be performed using data from drawings, operational procedures, integration documentation, and time lines to identify equipment with high power electromagnetic wave transmitters and the procedures to protect EVA crewmembers from harmful exposure to non–ionizing radiation. The verification shall be considered successful when the analysis verifies that the safing procedure to inhibit high power electromagnetic wave transmitters from operating during EVA proximity operations are properly documented.

4.3.9 MAINTAINABILITY AND MAINTENANCE

4.3.9.1 QUALITATIVE MAINTAINABILITY DESIGN

NVR

4.3.9.1.1 FAILURE DETECTION, ISOLATION, AND RECOVERY

4.3.9.1.1.1 MANUAL FAILURE, DETECTION, ISOLATION AND RECOVERY

A. Verification shall be by analysis using data from Hazard Analysis Reports, Reliability Block Diagram Analysis (RBDA), FMEA, schematics, Logistics Support Analysis Record (LSAR) and software detailed design drawings. The requirements are considered successful when the analysis shows that human/equipment interfaces such as visual display devices, cursor control devices, and manual input devices are in accordance with SSP 50005, paragraph 12.3.2.1.

B. Verification shall be by analysis using data from Hazard Analysis Reports, RBDA, FMEA, schematics, LSAR and software detailed design drawings. The requirements are considered successful when the analysis shows that general and specialized lighting are in accordance with the requirements.

C. Verification shall be by analysis using data from Hazard Analysis Reports, RBDA, FMEA, schematics, LSAR and software detailed design drawings. The requirements are considered successful when the analysis shows compliance with paragraph 3.9.1.1.1.C.

D. Verification shall be by analysis using data from Hazard Analysis Reports, RBDA, FMEA, schematics, LSAR and software detailed design drawings. The requirements are considered successful when the analysis show that structural, mechanical, electromechanical and electrical equipment are in accordance with the requirements as specified.

E. Verification shall be by analysis using data from Hazard Analysis Reports, RBDA, FMEA, schematics, LSAR and software detailed design drawings. The requirements are considered successful when the analysis shows that they are in accordance with paragraph 3.9.1.1.1.E.

4.3.9.1.2 RESERVE

4.3.9.1.3 ACCESS

A. Verification shall be by inspection and analysis of drawings. The verification shall be considered successful when the inspection and analysis shows that the Attached Payload provides physical and visual access to all payload installation, operations, and maintenance tasks.

B. Verification shall be by inspection and analysis of drawings. The verification shall be considered successful when the inspection and analysis shows that the Attached Payload provides access to inspect or replace an ORU without removal of another ORU or more than one access cover.

C. Verification shall be by inspection and analysis of drawings. The verification shall be considered successful when the inspection and analysis shows that the Attached Payload provides EVA access to remove and replace an ORU in accordance with SSP 50005, paragraphs 14.3.2.3.1 and 14.4.3.

D. Verification shall be by inspection and analysis of drawings. The verification shall be considered successful when the inspection and analysis shows that the Attached Payload meets the requirement of 3.9.1.3 D.

4.3.9.1.4 NONPRESSURIZED AREA EQUIPMENT MAINTENANCE TIME

A. Verification shall be performed by analysis consisting of integrating program generated documentation from maintainability data and data made available from engineering tests and worksite analysis. The verification shall be considered successful when the integrated analysis proves that the equipment is designed such that the maintenance subtasks can be completed in a single EVA sortie of less than 3 hours.

B. Verification shall be performed by analysis consisting of integrating program generated documentation from maintainability data and data made available from engineering tests and worksite analysis. The verification shall be considered successful when the integrated analysis proves that the requirements can be met.

4.3.9.1.5 ACCESS ITEM RETAINMENT

Verification shall be by analysis and inspection. An analysis shall be performed using the engineering design drawings and data obtained from neutral buoyancy and 1–g development testing. The inspection of design drawings shall show that the design incorporates restraining provisions for removable items based on the analysis. The verification shall be considered successful when the analysis, test data and inspections show that the covers, caps, and other structural parts, removed to gain access for a planned maintenance task, are capable of being retained clear of the worksite working volume.

4.3.9.1.5.1 CAPTIVE PARTS

Captive parts shall be verified by demonstration and inspection. Verification shall be considered successful when a demonstration and inspection shows that all unrestrained parts that are temporarily removed on orbit are held captive.

4.3.9.1.6 INSTALLATION/REMOVAL

4.3.9.1.6.1 METHOD

Verification shall be by analysis. The analysis shall determine that replaceable items (ORUs or maintenance items) are removable with the gloved hand alone or with common hand tools. The verification shall be considered successful when all replaceable items are removable with the gloved hand alone or with the common hand tools found in the EVA Tool List in SSP 30256:001.

4.3.9.1.6.2 EQUIPMENT ITEM INTERCONNECTING DEVICES

An analysis shall be performed using equipment/installation drawings, maintenance procedures contained in the LSAR, maintainability analysis and data obtained from neutral buoyancy and 1–g development testing, and hardware integration testing. The verification shall be considered successful when the analysis proves that utility line attachment/mounting length has been provided for maintenance.

4.3.9.1.6.3 INCORRECT EQUIPMENT INSTALLATION

An analysis of engineering drawings shall be performed to verify that features are provided to preclude incorrect installation of equipment. The verification shall be considered successful when the analysis shows that physical provisions (i.e., guides, location pins, orientation marks, etc.) have been incorporated to control the likelihood of an incorrect installation.

4.3.9.1.6.4 LOCKWIRING AND STAKING

An inspection of drawings shall be performed to verify that no lockwire or staking is used. The verification shall be considered successful when inspection proves that no planned maintenance equipment installations or operational interfaces are lockwired or staked.

4.3.9.1.6.5 RESTRAINING AND HANDLING DEVICES FOR TEMPORARY STORAGE

A. An analysis of engineering design drawings shall be performed to verify that restraining and handling devices are provided for the EVA crew for equipment items designated for removal and replacement. The verification shall be considered successful when the analysis proves that these devices have been incorporated in the system design for the planned temporary storage.

B. An analysis of engineering design drawings shall be performed to verify that restraining and handling devices are provided for external equipment items that use robotic devices to provide temporary storage. The verification shall be considered successful when the analysis proves that these devices have been incorporated in the system design for the planned temporary storage.

4.3.9.1.6.6 INSTALLATION/REMOVAL FORCE

Push–pull forces shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware shows that hardware mounted into a capture–type receptacle that requires push–pull action requires a force less than 35 1bf (156 N) to install and remove.

4.3.9.1.6.6.1 DIRECTION OF REMOVAL

Direction of Removal shall be verified by analysis. Verification shall be considered successful when an analysis of the Attached Payload flight hardware drawings shows that an Attached Payload ORU can be removable along a straight path.

4.3.9.1.6.6.2 VISIBILITY

Visibility shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware drawings shows that all forward edges of the payload equipment item are visible to the restrained crewmember during alignment and attachment.

4.3.9.1.6.6.3 MOUNTING ALIGNMENT

A. Alignment methods shall be verified by inspection. Verification shall be considered successful when an inspection shows the equipment items are properly marked, labeled or designed to facilitate proper installation.

B. Alignment marks shall be verified by inspection. Verification shall be considered successful when an inspection shows the alignment marks are applied to mating parts and (1) the marks are aligned in the installed position, and (2) the marks consist of a straight or curved line of a width and length to allow accurate alignment.

C. Electrical connector shell alignment and mating shall be verified by inspection. Verification shall be considered successful when an inspection shows the electrical connectors meet the requirements of 3.9.1.6.6.3 C.

4.3.9.1.6.7 ORBITAL REPLACEMENT UNIT

4.3.9.1.6.7.1 CAPTURE LATCH ASSEMBLY & UMBILICAL MECHANISM ASSEMBLY EXTRAVEHICULAR ACTIVITY OVERRIDE

Verification shall be by analysis. Verification shall be considered successful when an analysis of the Attached Payload flight drawings (on orbit configuration) shows that EVA access for CLA & UMA override has been provided in accordance SSP 30256.

4.3.9.1.6.7.2 PAYLOAD ATTACH SYSTEM AND UNPRESSURIZED CARGO CARRIER ATTACH SYSTEM ORBITAL REPLACEMENT UNIT EXTRAVEHICULAR ACTIVITY MAINTENANCE

Verification shall be by analysis. Verification shall be considered successful when an analysis of the Attached Payload flight drawings (on orbit configuration) shows that EVA access for PAS & UCCAS ORU (CLA, UMA & Guide Vane) maintenance per SSP 50005 has been provided.

4.3.9.1.6.7.3 ATTACHED PAYLOAD REMOVE/REPLACE ITEMS

Verification shall be by analysis. An analysis shall be performed using maintainability data to define those repairs to be performed on orbit and determine EVA capability in accordance with SSP 50005. The verification shall be considered successful when data shows that the Attached Payload is maintainable by EVA.

4.3.9.1.7 STANDARD EVA/EVR INTERFACES

A. An analysis of engineering design drawings shall be performed to verify that standard EVA interfaces are used with equipment items designated for on-orbit, maintenance in nonpressurized areas. The verification shall be considered successful when the analysis proves that each device to be manipulated by EVA is in accordance with SSP 30256:001.

B. An analysis of engineering design drawings shall be performed to verify that standard EVR interfaces are used with equipment items designated for on-orbit, maintenance in nonpressurized areas. The verification shall be considered successful when the analysis proves that each device to be manipulated by EVR is in accordance with SSP 42004 and SSP 42003, Space Station Manned Base to Mobile Servicing System ICD.

4.3.9.1.7.1 EXTRAVEHICULAR ACTIVITY TOOLS

Verification shall be by inspection of design drawings and test data. The Verification shall be considered successful when the inspection show that the Attached Payload is externally maintainable with the specified tools of SSP 30256:001.

4.3.9.1.7.1.1 TOOL CLEARANCE

A. Verification shall be by inspection of design drawings and test data. Verification shall be considered successful when the data shows that the Attached Payload equipment and structures surrounding bolts requiring EVA ratcheting shall protect a 90 degree throw angle and shall allow right or left handed operation.

B. Verification shall be by inspection of design drawings and test data. Verification shall be considered successful when the data shows that the Attached Payload structure surrounding tool actuated fasteners provides the proper clearance as shown in figure 3.9.1.7.1.1–1.

C. Verification shall be by inspection of design drawings and test data. Verification shall be considered successful when the data shows that the Attached Payload provides tool head clearance as defined in Figure 3.9.1.7.1.1–1.

4.3.9.1.7.2 PAYLOAD HARDWARE AND EQUIPMENT MOUNTING

A. Equipment Mounting shall be verified by demonstration and inspection. The verification shall be considered successful when the demonstration and inspection shows that the payload hardware is designed, labeled, or marked to prevent improper installation.

B. Alignment marks shall be verified by demonstration and inspection. The verification shall be considered successful when the demonstration and inspection shows that the payload hardware alignment marks that are used are consistent and on both mating parts.

4.3.9.1.7.3 CONNECTORS

Verification shall be by inspection. Verification shall be considered successful when the inspection of Attached Payload flight drawings and hardware shows connectors conform to the design requirements in SSP 50005, paragraph 14.6.4.3.

4.3.9.1.7.3.1 ONE–HANDED OPERATION

A. One–handed operation shall be verified by demonstration. Verification shall be considered successful when the demonstration shows the all connectors can be mated/demated using only one hand.

B. One–handed operation shall be verified by demonstration. Verification shall be considered successful when the demonstration shows the design and placement of connectors does not preclude the use of either hand.

4.3.9.1.7.3.2 MATE/DEMATE

A. Accessibility shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware drawings shows that it is possible to mate/demate individual connectors without having to remove or mate/demate other connectors.

B. Verification shall be by analysis. Verification shall be considered successful when an analysis of the payload hardware drawings shows that it is possible to disconnect and reconnect electrical connectors and cable installations without damage to wiring connectors.

4.3.9.1.7.3.3 CONNECTOR ARRANGEMENT

A. Verification shall be by inspection. Inspection of Attached Payload flight drawings will be used to evaluate spacing and connector arrangement. Verification shall be considered successful when it is shown that the space between connectors and adjacent obstructions shall be a minimum of 1.6 inches for EVA access.

B. Verification shall be by inspection. Inspection of Attached Payload flight drawings will be used to evaluate connector arrangement. Verification shall be considered successful when it is shown that the requirement of 3.9.1.7.3.3 B is met.

4.3.9.1.7.3.3.1 STATUS

Verification shall be by demonstration. The demonstration shall show that connector mating status can be determined. The verification shall be considered successful when a method exists to determine connector mating status.

4.3.9.1.7.3.4 CONNECTOR PROTECTION

Connector protection shall be verified by analysis. Verification shall be considered successful when an analysis shows that protection is provided for all demated connectors against physical damage and contamination.

4.3.9.1.7.3.4.1 PROTECTING CAPS

Verification shall be by inspection. Verification shall be considered successful when an inspection of the Attached Payload flight hardware shows that all connector protective caps are tethered.

4.3.9.1.7.3.5 CODING

A. Coding shall be verified by inspection. Verification shall be considered successful when an inspection shows that both halves of mating connectors display a code or identifier which is unique to that connection.

B. Coding shall be verified by inspection. Verification shall be considered successful when an inspection shows that labels or codes on connectors are visible when connected or disconnected.

4.3.9.1.7.3.6 PIN IDENTIFICATION

Pin identification shall be verified by inspection. Verification shall be considered successful when an inspection shows that each pin in each electrical plug and electrical receptacle is identified either on the plug or receptacle or on an accompanying chart.

4.3.9.1.7.3.7 ORIENTATION

Orientation shall be verified by inspection. Verification shall be considered successful when an inspection shows that grouped plugs and receptacles are oriented so that the aligning pins or equivalent devices are in the same relative position.

4.3.9.1.7.3.7.1 SPACING

A. Connector arrangement shall be verified by inspection. Verification shall be considered successful when an inspection of the space between connectors and adjacent obstructions comply with the requirement.

B. Connector arrangement shall be verified by inspection. Verification shall be considered successful when an inspection of connectors in a single row or staggered rows comply with the requirements.

4.3.9.1.7.4 CABLE RESTRAINTS

A. Cable/flexhose restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that the loose ends of cable/flexhose are restrained.

B. Cable/flexhose restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that EVA compatible clamps are provided in the proximity of connectors identified for possible mating/demating during on orbit operations.

C. Cable/flexhose restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that conductors, bundles, or cables are secured by a means of clamps unless they are contained in wiring ducts or cable retractors.

D. Cable bundles shall be verified by inspection. Verification shall be considered successful when an inspection shows that if multiple cables are running in the same direction, they are bundled.

4.3.9.1.7.5 COVERS

A. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows that access covers are provided if required.

B. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows that closures are removable.

C. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows that closures have a positive means of indicating tha they are locked.

D. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows that non–structural closures are capable of sustaining EVA–induced loads as specified in Table 3.1.1.2.6–1.

E. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows that other units do not interfere with removal or opening of covers.

F. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows that covers not completely removable are self–supporting in the open position.

G. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows that equipment housings in inaccessible areas provide closures and covers.

H. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirements of 3.9.1.7.5 H have been met.

4.3.9.1.7.6 FASTENERS

Verification shall be by inspection. Verification shall be considered successful when it is shown through the inspection of Attached Payload flight drawings that the fastener design requirements are in accordance with SSP 50005, paragraphs 11.9.3 through 14.6.3.3.

4.3.9.1.7.6.1 ENGAGEMENT STATUS INDICATION

A. Verification shall be by inspection. Verification shall be considered successful if the inspection shows that EVA actuated fasteners/devices are visually accessible to ensure proper seating or restraint in stowed or installed locations.

B. Verification shall be by inspection. Verification shall be considered successful if the inspection shows that EVA actuated fasteners/devices provide indication of correct engagement.

4.3.9.1.7.6.2 ONE–HANDED ACTUATION

One handed actuation shall be verified by demonstration. Verification shall be considered successful when fasteners can be actuated with one hand, not to preclude either hand.

4.3.9.1.7.6.3 FASTENER CLEARANCES

A. Fastener clearances shall be verified by inspection. Verification shall be considered successful when an inspection shows that tool clearances are as specified in 3.9.1.7.6.3.

B. Fastener clearances shall be verified by inspection. Verification shall be considered successful when an inspection shows that fasteners are separated to provide clearances in accordance with SSP 50005, Figure 14.6.2.3.

C. Fastener clearances shall be verified by inspection. Verification shall be considered successful when an inspection shows that the clearances are as specified for fasteners recessed in a robotic interface.

4.3.9.1.7.6.4 FASTENER ACCESS HOLES

Access holes for fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that covers or shields through which mounting fasteners must pass for attachment to the basic chassis of the unit have holes for passage of the fastener, and hand or necessary tool if either is required to replace, without precise alignment.

4.3.9.1.7.6.5 CAPTIVE FASTENERS

A. Captive fasteners shall be verified by analysis. Verification shall be considered successful when an analysis shows that all external fasteners are captive when disengaged.

B. Exclusion of temporary fasteners shall be verified by analysis. Verification shall be considered successful when an analysis shows that no fasteners on external hardware are temporary.

4.3.9.1.7.6.6 QUICK RELEASE FASTENERS

A. Quick release fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that fasteners require a maximum of one complete turn to operate.

B. Quick release fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that fasteners are positive locking in open and close positions.

4.3.9.1.7.6.7 OVER CENTER LATCHES

A. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection shows that there is a provision to prevent undesired latch element realignment, interface, or reengagement.

B. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection show that latch catches have a locking feature.

C. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection shows that the latch handle and latch release are operable by one hand.

4.3.9.1.7.6.8 FASTENER HEADS AND KNOBS

A. Fastener head type shall be verified by inspection. Verification shall be considered successful when an inspection shows that the fastener and knobs for suited gloved hand operations have a minimum head diameter of 1.5 inches and a maximum diameter of 2 inches.

B. Fastener head height shall be verified by inspection. Verification shall be considered successful when an inspection shows that the fastener head height minimum is .75 inches.

4.3.9.1.7.6.9 CONTINGENCY OVERRIDE

A. Verification shall be by inspection of design drawings. The drawings shall incorporate the specified EVA bolt head. Verification shall be considered successful when the inspection shows that the Attached Payload provides a standard size internal or external hexagonal feature for contingency override with a hand tool.

B. Verification shall be by inspection of design drawings. Verification shall be considered successful when the inspection shows that the Attached Payload does not use cotter pins.

4.3.9.1.7.7 CONTROLS AND DISPLAYS

4.3.9.1.7.7.1 CONTINGENCY EXTRAVEHICULAR ACTIVITY CONTROLS

A. Verification shall be by inspection of design drawings. Verification shall be considered successful when the inspection shows that the Attached Payload conforms to the requirements in SSP 50005, paragraph 9.2 and provides tactile and/or visual indication of position of actuated switches.

B. Verification shall be by inspection of design drawings. Verification shall be considered successful when the inspection shows that the Attached Payload conforms to the requirements in SSP 50005, paragraph 9.2 and provides protection of controls from inadvertent actuation.

4.3.9.1.7.7.2 DISPLAYS

A. Verification shall be by inspection of design drawings. Verification shall be considered successful when the inspection shows that the Attached Payload display types and locations conforms to the requirements in SSP 50005, paragraph 9.2 and 9.4.

B. Verification shall be by inspection of design drawings. Verification shall be considered successful when the inspection shows that the Attached Payload EVA displays are located within the field of view permitted by the EMU as defined in 3.8.3.1.1.2

4.3.9.1.7.7.3 LABELING

Verification shall be by inspection of design drawings. Verification shall be considered successful when the inspection shows that the Attached Payload labeling and color coding conforms to the requirements in Appendix C.

4.3.9.2 MAINTENANCE

4.3.9.2.1 PLANNED MAINTENANCE OR STORAGE

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify hardware edge and corners requiring rounding, the use of guards, or covers due to the item being relocated in a pressurized volume. A drawing inspection shall show that the required edge and corner rounding, deburring, or cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that all required edges or corners have been properly machined, covered or guarded.

4.3.9.2.2 ON-ORBIT MAINTENANCE

A. An analysis of engineering design drawings shall be performed to verify that personnel and equipment mobility aids and restraining devices are provided to support on–orbit maintenance. The verification shall be considered successful when the analysis proves that these devices have been incorporated in the system design for the planned on–orbit maintenance.

B. Analysis shall be conducted using the FMEA, ORU selection rationale, and preventive maintenance analysis. The verification shall be considered successful when the analysis proves that the selected LSAR on-orbit maintenance tasks comply with the ORU selection criteria, rectify the projected failure modes, satisfy preventive maintenance restrictions, and apply the allowable tools listed in Tables 3.2-1 and 3.2-2 of SSP 30256:001 or provide adequate physical constraint rationale for exceptions.

4.3.9.2.2.1 CORRECTIVE MAINTENANCE

Analysis shall be conducted using the FMEA, ORU selection rationale, and preventive maintenance analysis. The verification shall be considered successful when the analysis proves that ORUs comply with selection criteria, rectify the projected failure modes, satisfy preventive maintenance analysis restrictions, and meet program defined resupply, return, and crew time allocations.

4.3.9.2.2.2 IN SITU MAINTENANCE

Analysis shall be conducted using the FMEA, ORU maintenance planning, and preventive maintenance analysis. The verification shall be considered successful when the analysis proves that the selected LSAR on–orbit in situ maintenance tasks rectify projected failure modes not corrected by ORU removal and replacement without operational capability degradation and satisfy preventative maintenance analysis restrictions.

4.3.9.2.2.3 ORBITAL REPLACEMENT UNIT INTERMEDIATE MAINTENANCE

Analysis shall be conducted using the FMEA, ORU selection rationale, and program defined resupply, return, and crew time allocations. The verification shall be considered successful when the analysis proves that the selected LSAR on–orbit intermediate maintenance tasks comply with the ORU selection criteria, rectify the projected failure modes, and meet program defined resupply, return and crew time allocations.

4.3.9.2.2.4 PREVENTIVE MAINTENANCE

Analysis shall be conducted using the FMEA and preventive maintenance analysis. The verification shall be considered successful when the analysis proves that the selected LSAR on–orbit preventive maintenance tasks rectify the projected failure modes and satisfy preventive maintenance analysis restrictions.

4.3.9.2.2.5 ON–ORBIT MAINTENANCE BACKUP

Analysis shall be conducted using the physical constraints of the ORU, the end item installation physical constraints and the applicable maintainability and human factors criteria. The verification shall be considered successful when the analysis of LSAR maintenance planning proves that no more than two astronauts would be required to perform the ORU remove and replace actions which have been designed and planned for robotic execution.

4.3.9.2.2.6 ACCESS FOR ON–ORBIT MAINTENANCE

Analysis shall be conducted using the FMEA, ORU selection, preventive maintenance analysis, development program test results, and program defined crew time allocations. The verification shall be considered successful when the analysis proves that LSAR on–orbit organizational maintenance tasks are in accordance with SSP 50005, paragraphs 12.3.1.2, Physical Accessibility Design Requirements, and 12.3.1.3, Visual Access Design Requirements and meet program defined crew time allocations.

4.3.9.2.2.6.1 EXTRAVEHICULAR ACTIVITY ACCESS TO FASTENERS

An inspection shall be performed to ensure that all recessed robotics compatible EVA fasteners provide clearance between the outer edge of the fastener and the robotics interface so that the drive end of a standard tool can be inserted, actuated, and removed. The inspection shall be considered successful when the Attached Payload and component drawings document that for each recessed robotics compatible EVA fasteners, clearance between the fastener outer edge and robotics interface have been provided.

4.3.9.2.2.7 STANDARD ON–ORBIT DIAGNOSTIC EQUIPMENT

Analysis shall be conducted using the LSAR maintenance planning resource reports. The verification shall be considered successful when the analysis proves that the LSAR on–orbit organizational maintenance tasks apply the allowable diagnostic equipment listed in SSP 30256:001, Tables 3.2–1, 3.2–2, or provide adequate physical constraint rationale for exceptions.

4.3.9.2.3 GROUND MAINTENANCE

Analysis shall be conducted using ORU selection criteria, Repair Level Analysis (RLA), and other logistic analyses of repair feasibility. The verification shall be considered successful when the analysis proves that depot resources are available or feasible for LSAR Depot maintenance tasks selected in accordance with program approved Logistics Support Analysis (LSA) physical and economic criteria.

4.3.10 NAMEPLATES AND PRODUCT MARKING

A. Labels on integrated Attached Payload, all (installed in the Attached Payload or separately) Attached Payload elements, loose equipment, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls shall be verified by inspection. The inspection shall be of the FCSD approval documentation. The verification shall be considered successful when integrated Attached Payloads, all (installed in the Attached Payload or separately) Attached Payload elements, loose equipment, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls have been shown to have FCSD approved labels. The instructions for FCSD to follow in granting approval of labels are located in Appendix C.

B. An analysis of engineering design drawings shall be performed to verify that marking techniques shall not degrade the structural integrity of the equipment. The verification shall be considered successful when the analysis proves that the requirements have been satisfied.

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APPENDIX A
ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
ACASS	Active Common Attach System Simulator
AO	Atomic Oxygen
APID	Application Process Identifier
APIRD	Attached Payload Interface Requirements Document
APPI	Attached Payload Port Interface
AWG	Average Wire Gage
BER	Bus Error Rate
CAS	Common Attach System
CCS	Command and Control System
CCSDS	Consultative Committee for Space Data Systems
CG	Center of Gravity
CLA	Capture Latch Assembly
cm	Centimeter
CMG	Control Moment Gyroscope
C&DH	Command & Data Handling
CCSDS	Consultative Committee for Space Data Systems
C&W	Caution and Warning
COTS	Commercial Off The Shelf
CUC	CCSDS Unsegmented Time Code
dB	decibel
dBm	decibels Referenced to one Milliwatt
dc	Direct Current
DDPF	Decal Design and Production Facility
EBCS	External Berthing Camera System
EEOCS	End Effector Coordinate System
EMC	Electromagnetic Compatibility
EMEP	Electromagnetic Effects Panel

EMI	Electromagnetic Interference
EMU	Extravehicular Mobility Unit
EPCE	Electrical Power Consuming Equipment
EPS	Electrical Power System
ESD	Electrostatic Discharge
EVA	Extravehicular Activity
EVR	Extravehicular Robotics
F	fahrenheit
FCSD	Flight Crew Support Division
FEM	Finite Element Model
FMEA	Failure Modes and Effects Analysis
FPS	Feet Per Second
GPS	Global Positioning System
HRDL	High Rate Data Link
HRFM	High Rate Frame Multiplexer
Hz	Hertz
ICD	Interface Control Document
IRD	Interface Requirements Document
ISS	International Space Station
ISSP	International Space Station Program
ITA	Integrated Truss Assembly
ITS	Integrated Truss Segment
JEM	Japanese Experiment Module
kHz	kiloHertz
kW	kiloWatt
lbf	pounds force
lbm	pounds mass
lb	pound

LED	Light Emitting Diode
LEE	Latching End Effector
LISN	Line Impedance Simulation Network
LRDL	Low Rate Data Link
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Record
mA	milliAmperes
MBS	Mobile Remote Servicer Base System
MCAS	Mobile Base System Common Attach System
MCF	Micro Conical Fitting
MDM	multiplexer–demultiplexer
MHz	Mega Hertz
MLI	Multi–Layer Insulation
mm	Millimeters
MMCH/Y	Mean Maintenance Crew Hour Per Year
M/OD	Meteoroids and Orbital Debris
MRB	Microgravity Rack Barrier
MRS	Mobile Remote Servicer
ms	Milleseconds
MSC	Mobile Servicing Centre
MSS	Mobile Servicing System
MT	Mobile Transporter
NASA	National Aeronautics and Space Administration
NDE	Non–destructive Evaluation
NSTS	National Space Transportation System
NVR	No Verification Required
OLR	Outgoing Long–Wave Radiation
ORU	Orbital Replacement Unit
OTCMOCS	ORU/Tool Changeout Mechanism Operating Coordinate System

PAS	Payload Attach System
PCB	Payload Control Board
PCS	Portable Computer System
PD	Payload Developer
PDGF	Power Data Grapple Fixture
PFE	Portable Fire Extinguisher
PFR	Portable Foot Restraint
PIA	Payload Interface Agreement
PIT	Pre–Integrated Truss
POA	Payload/ORU Accommodations
PRCU	Payload Rack Checkout Unit
psia	pounds per square inch absolute
PSRP	Payload Safety Review Panel
PTR	PIRN Technical Review
PVGF	Power Video Grapple Fixture
QCM	Quartz Crystal Microbalance
RBDA	Reliability Block Diagram Analysis
RCS	Reaction Control System
RLA	Repair Level Analysis
RMS	Root Mean Square
ROEU	Remote Operated Umbilical
RPC	Remote Power Controller
RPCM	Remote Power Control Mechanism
RT	Remote Terminal
sec	second
SDGF	Standard Dexterous Grasp Fixture
SEE	Single Event Effect
SPDM	Special Purpose Dexterous Manipulator
SRMS	NSTS Remote Manipulator System
SRU	Shop Replaceable Unit
SSRMS	Space Station Remote Manipulator System

SSP	Space Station/Shuttle Program
SSQ	Space Station Qualified
STEP	Suitcase Test Environment for Payloads
SWG	Structures Working Group
TBD	to be determined
TIA	Tailoring/Interpretation Agreement
TM	Technical Memo
UCC	Unpressurized Cargo Carrier
UCCAS	Unpressurized Cargo Carrier Attach System
UMA	Umbilical Mechanism Assembly
USL	United States Laboratory
USOS	United States On–orbit Segment
V	Volts
VC–S	Visibly Clean – Standard
VDC	volts (direct current)
Vrms	volts root–mean–square
WIF	Worksite Interface Fixture

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APPENDIX B
GLOSSARY OF TERMS

Alignment Marks: Are straight or curved lines of sufficient length and width to allow alignment, are applied to both mating parts, align when the parts are in the installation position, and are visible during alignment and attachment.

Attached Payload: An integrated system that is carried into space on a launch vehicle and connected to a PAS/UCCAS/MCAS attach site.

Boss: Protruding hard–points for GSE attachment.

Catastrophic Hazard: Any hazard which causes loss of on–orbit life sustaining system function.

Component: An equipment item that is part of an integrated system or payload and is treated as an entity for the purposes of load analysis (example are electronic boxes, batteries, antennas, stored energy devices, electromechanical devices, and scientific instruments or experiments).

Critical Hazard: Any hazard which may cause a non–disabling injury, severe occupational illness, loss of emergency procedures, or involves major damage to one of the following: the launch or servicing vehicle, manned base, an on–orbit life–sustaining function, a ground facility or any critical support facility.

Current Limiting: The current is limited to a specific level plus or minus a percentage for tolerance.

EPCE: Equipment that consumes electrical power including battery powered equipment.

Hazard: The presence of a potential risk situation caused by an unsafe act or condition.

Line Impedance Stabilization Network: An electrical circuit, including resistance, capacitance, and inductance, used to simulate a specific power bus.

Narrow–band Disturbance Force: A force which peaks within a frequency range.

Narrow–band Peak Enveloped Force Limit: The integrated attached payload microgravity disturbance allocation applicable to those one–third octave bands in which the peak power spectrum disturbance force at any frequency divided by the average disturbance force is greater than or equal to five.

Non–Normal: Pertaining to performance of the Electrical Power system outside the normal design due to ISS system equipment failure, fault clearing, 0r overload conditions.

Operate: Perform intended design functions given specified conditions.

Orbital Replaceable Unit: The designated level of system hardware that is permitted to be removed and replaced on location under orbital conditions.

Primary Structure: The structure that is the principal load path for all subsystems, components, and other structures.

Quasi–Steady Acceleration: ISS accelerations in the frequency range below .01 Hz. This limit is defined to be consistent with SSP 50036 so that the maximum average acceleration contribution from no integrated attached payload exceeds .02 micro–g continuously nor exceeds 10 micro–g seconds over any period of time not protected by the continuous limit.

Safety–Critical: Having the potential to be hazardous to the safety of hardware, software, and personnel.

Secondary Structure: The structure that is part of an integrated system or payload and is not a principal load path for the purposes of load analysis (examples are wire harness disconnect panels, brackets, or mounting plates).

Standard Conditions: Measured volumes of gases are generally recalculated to 0 degrees C temperature and 760 mm Hg pressure, which have been arbitrarily chosen as standard conditions.

Wide–band Disturbance Force: A force which occurs with uniform intensity over a frequency range.

Wide–band Force Limit: The integrated attached payload microgravity disturbance allocation applicable to those one–third octave bands in which the peak power spectrum disturbance force at any frequency divided by the average disturbance force within the band is less than five.

Wire derating: Wire is derated based on the current flow, environment, electrical circuitry that operates within electrical power consuming equipment individual boxes.

APPENDIX C
INSTRUCTIONS FOR LABELS AND DECALS

C.1 INTRODUCTION

Appendix C provides the instructions for the approval of Attached Payload labels. The development of labels will be a joint process requiring the cooperative efforts of Flight Crew Support Division (FCSD) and the PD. The process for developing labels, from the beginning to the delivery of flight certified labels which have been approved by the FCSD, is documented in Figure C.1–1.

To understand the priorities of the instructions, the following definitions need to be applied throughout Appendix C.

Statements with ”must” will be used for instructions which are required to be met for the FCSD to provide approval.

Statements with ”should” will be used for instructions which are incorporated into the label unless adequate justification is provided to FCSD to warrant exempting the label instruction.

C.2 RESPONSIBILITIES

The PD is responsible for providing label drawings, label location drawings and information sufficient to enable FCSD to determine the instructions herein are met. The PD will coordinate with FCSD before submitting the label drawings for approval.

FCSD is responsible for reviewing all Attached Payloads labels, providing guidance to the PD and granting approval based on the instructions herein. FCSD is also responsible for performing a human engineering assessment of the labels and ensuring the labels are appropriate from a human engineering perspective including commonality, standardization, and operations nomenclature. Upon receiving Form 733, FCSD has 10 working days for either assessing, approving, and verifying the labels or for providing redlines to the label drawings.

The PTR is responsible for resolving issues and disagreements between PD and FCSD.

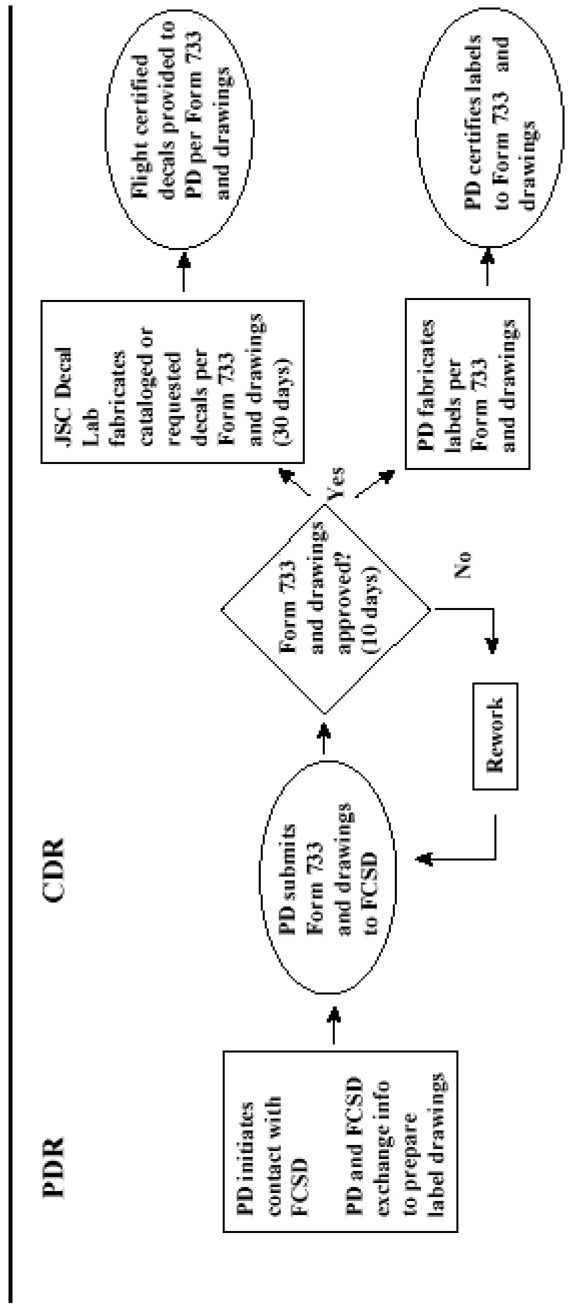


FIGURE C–1 LABEL PROCESS

C.3 FCSD APPROVAL INSTRUCTIONS

FCSD will use the following instructions in reviewing and providing the approval of payload labels.

C.3.1 GROUND ASSEMBLY AND HANDLING

Product marking for ground assembly and handling should be in accordance with MIL–STD–130, section 4, except paragraph 4.1.c.

C.3.2 FUNCTION CONSIDERATIONS

A. Decals and placards should contain information required by the user, the purpose, the function, and/or the functional result of the use of equipment items. Engineering characteristics or nomenclature may be described as a secondary consideration.

B. Instrument decals and placards, for example, should be labeled in terms of what is being measured or controlled. Calibration data may be included where applicable.

C.3.3 PAYLOAD ORIENTATION

Payload labeling, displays, and controls must have a consistent local vertical orientation arrangement.

C.3.4 CONTAINER CONTENT IDENTIFICATION

Containers must be labeled to identify its contents.

C.3.5 LABELING DESIGN

C.3.5.1 LABELING STANDARDIZATION

A. Decals needed by the PD which are available in JSC 27260, Decal Process document and Catalog must be obtained from the Decal Design & Production Facility (DDPF). Examples of labels found in the catalog are: IMS, PFE, toxicology, hazardous, cautions and warning, rack power switch, fire indicators, etc. The DDPF is also available to the PDs for fabricating labels not found in JSC 27260.

B. Labeling should be standardized between and within systems.

C. Different labeling categories should be distinct from one another.

D. The textual content of labels must conform to the operational nomenclature provided in SSP 50254, Operations Nomenclature and JSC 36044.

C.3.5.2 READABILITY

A. Decals and placards should be as concise and direct as possible.

B. Abbreviations

(1) Upper and lower case letters should be used as appropriate.

(2) Periods should be omitted except when needed to preclude misinterpretation.

C. Decal and Placard Life

Payloads must provide readable labels for the lifetime of the payload.

D. Language

(1) Decals and placards must be written in the English language.

(2) If dual languages are used, English must be used first and with lettering at least 25% larger than the secondary language.

E. Decals and placards should be designed so as to minimize visual clutter.

F. Illumination – Labels and markings should be designed to be read at all general illumination levels and color characteristics of the illuminant as specified in SSP 57000 Table 3.12.3.4.–2.

G. A matte or lusterless finish must be used.

C.3.5.3 LABEL PLACEMENT

A. All labels must be placed on the payload hardware in accordance to the label location drawings.

B. Orientation – All markings and labels must be oriented with respect to the local worksite place so that they read from left to right. Vertical orientation is permissible only when the marking or label dimensionally does not fit in the required location.

C. Display Labels – labels identifying display functions must be placed on the panel above the display. Labels may be placed in locations other than above the display only when they cannot dimensionally fit in the required location.

D. Visibility – Markings should be located such that they are perpendicular to the operator's normal line of sight whenever feasible and must not be less than 45 degrees from the line of sight.

E. Association Errors – The Arrangement of markings on panels should protect against errors of association of one marking or set of markings with adjacent ones.

F. Handrail Labels – The Attached Payload shall provide a numerical label to each EVA handrail enabling the EVA flight controller to plan an efficient translation path and transmit that information to the crew. The EVA crew can then use the labels to efficiently translate to and from the worksites on the ISS. The labels will also be used to identify permanent and temporary tethering locations for hardware.

C.3.5.4 EQUIPMENT IDENTIFICATION

A. Loose equipment must be marked with nomenclature that describes the function of the item and its pertinent interfaces. However, items whose use is obvious to the crew (e.g., food table, windows, etc.) are exempt from this instruction.

B. Multi–quantity Items

(1) Multi–quantity items that require individual distinction but are not serialized must be individually numbered.

(2) Serial Numbers – Multi–quantity items that are serialized should display the serial number as part of the identification.

C. Cables must be labeled to indicate the equipment to which they belong and the connectors to which they mate.

(1) All replaceable wires and cables must be uniquely identified with distinct number or color codes.

(2) Electrical conduits/fiber optics and fluid lines installed in pressurized areas must be identified at each end, and at intervals not to exceed 1 meter, in accordance with SSP 50014, section 3.

(3) Electrical conduits/fiber optics and fluid lines installed in unpressurized areas must be identified at each end, and at intervals not to exceed 5 meters, in accordance with SSP 50014, section 3.

D. For items intended to be removed or connected on–orbit (excluding internal unplanned maintenance cables)

(1) Labels at the terminal ends of a cable must contain the following information, arranged in vertical order:

– the name of the connector to which this end attaches.

– the name of the piece of equipment to which the cable belongs.

– the name of the connector at the other end of the cable to which the cable attaches in parentheses.

(2) Other labels

(a) Labels, other than at ends of cables, must contain only name of the piece of equipment to which the cable belongs.

(b) Each cable longer than 10 cm must have at least one label containing the name of the piece of equipment to which the cable belongs.

C.3.5.5 LOCATION AND ORIENTATION

C.3.5.5.1 LOCATION CODING

A. Access Panels – maintenance access panels must be labeled to assist the crew in locating the panel for maintenance activities.

(1) Access panel identification labels should be located in the lower left position on the panel with respect to the local vertical orientation.

C.3.5.5.2 ALIGNMENT MARKS/INTERFACE IDENTIFICATION

A. Alignment marks

(1) Alignment marks shall be applied to mating parts.

(2) Alignment marks shall consist of a straight or curved line of a width and length sufficient to allow accurate alignment.

B. Coding

(1) Both halves of mating connectors shall display a code or identifier which is unique to that connection.

(2) The labels or codes on connectors shall be located so they are visible when connected or disconnected.

C. Orientation – When a piece of hardware requires a specific orientation which cannot be identified by alignment marks, arrows and/or labels should be used to indicate the proper orientation.

D. Tethered Equipment – Interface identification should not be used for movable items tethered to a mating part (e.g., dust cap for an electrical connector, hinged lid for a stowage container).

C.3.5.6 OPERATING INSTRUCTION

A. Location – Equipment operating instructions should be located on or adjacent to equipment.

B. Equipment Name – The instructions should have the title of the equipment to be operated centered above the text.

C. Grouping – Instructions should be grouped and titled by category (e.g., installation, removal, activation, calibration, etc.).

D. Case – Instructional text should use upper and lower case letters.

E. Title Selection – The titles of equipment, displays, controls, switch positions, and connectors should be listed in upper case letters only.

  (1) Title nomenclature should be consistent with procedural handbooks and checklists.

F. Required Tools – Instruction for removal of stowage items, markings should be used for the location of the fasteners to be removed.

C.3.5.7 STOWAGE CONTAINER LABELING

A. Each stowage container label should list the containers contents on a surface visible to the crewmember.

B. Subdivided Containers:

  (1) If a stowage container is subdivided internally into smaller closed containers, the sub–containers must carry a list of contents.

  (2) If the available marking space on a sub–container is insufficient to display the complete content titles, a contents list must be displayed elsewhere and clearly identified as belonging to the sub–container.

(3) The specific contents of each sub–container and its code must be listed on the front surface of its container or near it.

C. Similar Item Labeling – Containers with designated locations for placement of equipment set (e.g., socket wrenches in a tool kit) should have each location identified with the title of the item stowed.

C.3.5.8 GROUPED DISPLAYS AND CONTROLS

A. Functional groups of controls must be identified (e.g., by common color, by boundary lines). A functional group of controls are all associated or connected with a common system or purpose. (e.g., CABIN AIR, FURNACE A, EXPERIMENT ”M”, PANEL LIGHTING).

B. Labels must be located above the functional groups they identify.

C. When a line is used to enclose a functional group and define its boundaries, the labels must be centered at the top of the group, in a break in the line.

(1) The width of the line must not be greater than the stroke width of the letters.

D. When displays and controls are used together in adjustments or activation tasks, visible labels or marking must indicate their functional relationships.

C.3.5.9 CAUTION AND WARNING LABELS

Caution and warning labels are required for indicating potentially undesirable conditions.

A. Caution and warning labels must be standardized between and within systems.

B. Caution and warning labels must be distinct from one another.

C. Caution and warning labels must identify the type of hazard and the action that would prevent its occurrence.

D. The caution and warning markings must be located in a visible area.

E. Emergency–Use Items

(1) Decals and placards on emergency–use items (e.g., repair kits, emergency lighting, fire extinguisher, etc.) must display the words ”EMERGENCY USE” surrounded by diagonal red and white stripes either on the item or adjacent to it.

(2) The emergency type warning stripes must be alternate red and white.

(3) The red and white stripes should be of equal width.

(4) There must be no fewer than four red stripes and three white stripes.

(5) The striping must be applied at a 45 degree angle rotated clockwise from the vertical.

(6) The striping must begin and end with a red stripe.

(7) The text must be white letters on the red background or red letters on a white background.

(8) For items located within a storage container, the diagonal striping must be applied to the door of the container and the titles of the emergency items must be included on the marking instead of the words EMERGENCY USE.

F. Warning Stripe Specification

(1) Caution/warning decals and placards must be surrounded by diagonal yellow and black stripes.

(2) The caution/warning type stripes must be alternate yellow and black.

(3) The yellow and black stripes should be of equal width.

(4) There must be no fewer than four yellow stripes and three black stripes.

(5) The striping must be applied at a 45 degree angle rotated clockwise from the vertical.

(6) The striping must begin and end with a yellow stripe.

(7) The text must be black letters on the yellow background.

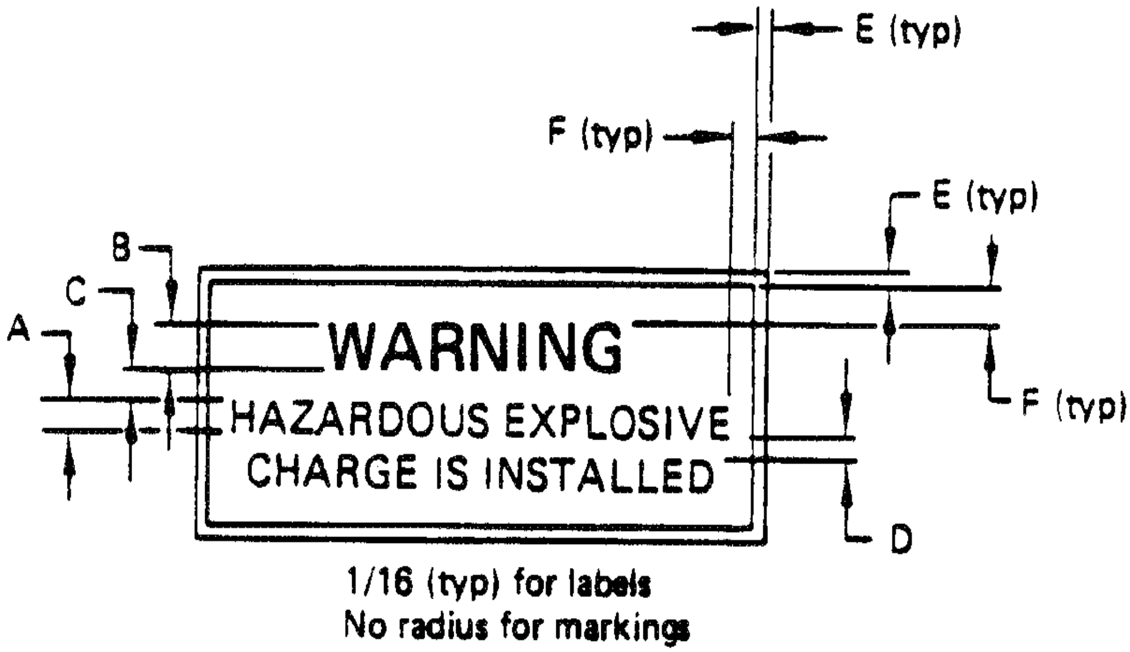
G. Switches and Buttons

(1) The striping around a switch or button must not be wider than 25 mm (1 in.) or narrower than 3 mm (0.125 in.).

(2) If one side of a switch or button has less than 3 mm (0.125 in.) space, no striping must be applied to that side.

H. Label Specifications – Hazard identification labels should use the letter size as specified in Figure C–3.

I. Control of Exposed Risk – External hardware posing a risk to EVA crew in the primary and secondary translation paths and established worksites shall be placarded and controlled as specified in Table C–1.



A – Text or minor lines of lettering	= A
B – Heading or major line of lettering	= 1.25A to 2A
C – Spacing between heading and text	= 0.65A to A
D – Spacing between lines of text	= 0.50A
E – Border width	= 0.60A
F – Background border	= A

FIGURE C–2 CONTROL OF EXPOSED RISK

TABLE C–1 CONTROL FOR EXPOSED RISKS TO EVA CREW

Risk Type	Hazard	Control Method *
Innate Characteristics	Nonionizing Radiation (Antennas transmit at 15 GHz)	Warning Strips and Placards
	Retract/Rotating Parts	Warning Strips and Placards
	Propulsion/Thrusters	Warning Strips and Placards
	Electrical/Connectors	Warning Strips and Placards
	Thermal (>235 degrees F or < –180 degrees F for 0.5 sec)	Warning Strips and Placards
	Stored Energy Devices/Pyrotechnics	Warning Strips and Placards
	Magnetic Field	Warning Strips and Placards
	Venting of Corrosives	Warning Strips and Placards
By Design	Sharp Edges/Corners	Placards
	Narrow Passageways Protrusions	Placards
	Structure Sensitive to EVA Loads	Placards
	Pinch Points	Placards
	Noncorrosive Contaminants	Placards
	Abrasion Areas	Placards

Note: *Control methods will be designed in accordance with SSP 50005, paragraph 9.5.3.1.

C.3.5.10 ALPHANUMERIC

C.3.5.10.1 FONT STYLE

A. The font style used on decals, placards, and labels must be Helvetica or Future demibold. If there are fit problems:

– The use of condensed type (Helvetica Condensed) or abbreviations is the preferred method of solving line length.

or

– For engraved markings which are not able to exactly match the above required font, the engraved marking should match the Helvetica font as nearly as possible.

Note: Helvetica is the preferred font.

B. Stenciled Characters – Stencil–type characters should not be used on display/control panels or other equipment.

C.3.5.10.2 PUNCTUATION

A. Periods – Periods (.) should not be used in equipment labels.

B. Hyphens – Hyphens (–) should not be used in equipment labels, except in part numbers.

C. Parentheses and Ampersands – Parentheses and ampersands should not be used on the display and control panel or other crew equipment.

D. Slashes – The backslash (/) may be used in place of the words ”and” and ”or” and may be used to indicate multiple functions.

C.3.5.10.3 SPECIAL CHARACTER

A. Subscript and Superscript Size – Subscripts and superscripts should be 0.6 to 0.7 times the height of associated characters.

B. Subscripts – Numeric subscripts and upper case letter subscripts should be centered on the baseline of associated characters.

C. Lower Case Letter Subscripts – The base of lower case letters and the ovals of g, p, q, etc., should be at the same level as the base of adjacent capital letters.

D. Degree Symbol – The degree symbol should be centered on an imaginary line extended from the top of the F or C symbols.

E. Pound or Number Symbol (#) – The pound or number symbol should be centered on an imaginary line extended from the top of the associated numerals and placed two stroke widths away from them.

C.3.5.10.4 CHARACTER HEIGHT

A. Character Height – Character height depends on viewing distance and luminance level. At a viewing distance of 710 mm (28 in.), the height of letters and numerals should be within the range of values given in Table C.3.6.10.4–1.

B. Variable Distance – For a distance (D) other than 710 mm (28 in.), multiply the values in Table C.3.5.10.4–1 by D/710 mm (D/28 in.) to obtain the appropriate character height.

TABLE C–2 CHARACTER HEIGHT – 710 MM (28 IN) VIEWING DISTANCE

Markings	Character Height	
	3.5 cd/m^2 (1 ft–L) or below	Above 3.5 cd/m^2 (1 ft–L)
For critical markings with position variable (e.g., numerals on counters and settable or moving scales)	5.8 mm (0.20 – 0.31 in.)	Above 3.5 cd/m^2 (l ft–L) (0.12–0.20 in.)
For critical markings, with position fixed (e.g., numerals on fixed scales, controls, and switch markings, or emergency instructions)	4–8 mm (0.16–0.31 in.)	2.5–5 mm (0.10–0.20 in.)
For noncritical markings (e.g., identification labels, routine instructions, or markings required only for familiarization)	1.3–5 mm (0.05–0.20 in.)	1.3–5 mm (0.050–0.20 in.)

C. Size Categories – Characters used in labeling should be graduated in size. To determine character height, all nomenclature on a label may be divided into three categories: titles, subtitles, and text. The nominal heights at a viewing distance of 710 mm (28 in.) for each category should be:

(1) Titles, 5 mm (0.19 in.)

(2) Subtitles, 4 mm (0.16 in.)

(3) Text, 3 mm (0.12 in.)

When more than one character size is used in labeling, there should be at least a 25 percent difference in the character height for each character set.

D. Space Limitations – The use of the same size letters and numerals for all categories on a label is acceptable for solving space limitation and clarity problems. The height of lettering and numerals should not be less than 3 mm (0.12 in.).

C.3.5.10.5 CHARACTER WIDTH

A. Letter – The width of letters should be 0.6 of the height, except for the letter ”I”, which should be one stroke in width, the letter ”J” and ”L”, which should be 0.5 of the height, the letter ”M”, which should be 0.7 of the height, and the letter ”W”, which should be 0.8 of the height.

B. Numerals – The width of numerals should be 0.6 of the height, except for the number ”4”, which should be one stroke width wider and the numeral ”1”, which should be one stroke in width.

C. Wide Characters – When wider characters are used on a curved surface, the basic height–to–width ratio should be increased to 1:1.

C.3.5.10.6 STROKE WIDTH

A. Height–to–Stroke Ratio – Marking letters and numerals should have height–to–stroke ratio of 5:1 to 8:1.

B. Transillumination Background – Opaque markings on a transilluminated lighted background should have a height–to–stroke ratio of 5:1 to 6:1.

C. Transilluminated Markings – Transilluminated markings on a dark background or markings used on integrally lighted instruments should have a height–to–stroke ratio of 7:1 to 8:1.

D. General Purpose Illumination – Characters used on display panels and equipment when viewed under general purpose flood lighting or normal display conditions as specified in Table C–2 should have a height–to stroke ratio of 6:2 to 7:1.

C.3.5.10.7 CHARACTER MEASUREMENT

A. Measurement – All letters and numeral measurement should be made from the outside edges of the stroke lines for other than machine engraving on opaque surfaces.

B. Engravings – For all mechanical engraving on opaque surfaces, the dimensions controlling the size of letters and numerals should be measured from centerline to centerline of the stroke.

C.3.5.10.8 SPACE

A. Character Spacing – The spacing between letters within words and between digits in a multi–digit number should be the equivalent of one stroke width between two straight–sided letters such as H and 1. (This instruction intended to accommodate the normal commercial typographical practice of spacing letters to achieve a consistent visual continuity. This permits close spacing of open letters such as C and T to avoid large apparent gaps.)

B. Word Spacing – The spacing between words should be equivalent of the letter W between two straight–sided letters such as N and F.

C. Line Spacing

(1) The spacing between the lines of related text should be 0.5 of upper case letter height.

(2) Spacing between headings and text should be 0.6 to 1.0 of upper case letter height.

C.3.5.11 BAR CODING

A. Attached Payload, loose equipment, consumables, and ORUs must have an inventory management label in accordance with SSP 50007.

B. Decals, labels, or placards using bar coding for identification must use a code 39 bar code number system per MIL–STD–1189, and SSP 50007.

C. Payloads should not provide the hardware name on the inventory management labels.

C.3.6 CODING

Color identification numbers used below are per FED–STD–595–B.

A. Color Difference

(1) Only one hue within a color category (e.g., reds, greens) should be used on the decals or placards within the same integrated rack.

(2) That color must always be associated with a single meaning within the same system or integrated rack.

B. Number of Colors – No more than 9 colors, including white and black, must be used in a coding system.

C. Placards – Placards should adhere to the accepted combinations of markings and background color listed below:

– Markings/Background

– White/Black

– Black/Yellow

– Black/White

– Yellow/Blue

– White/Red

– Red/White

– Blue/Yellow

– White/Grey

C.3.7 SCALE MARKING

A. Accuracy

(1) The precision of scale markings should be equal to or less than the precision of the input signal.

(2) In general, scales that are to be read quantitatively to the nearest graduation mark should be designed so that interpolation between graduation marks is not necessary. Interpolation, should be limited to one half the distance between minor graduation marks.

B. Interval Values

(1) The graduation intervals should progress by 1, 5, or 2 units of decimal multiples thereof, in that order of preference.

(2) The number of graduation marks between numbered graduation marks should not exceed 9.

C. Scale Markings (High Luminance – above 1 ft–L)

(1) The minimum width of major, intermediate, and minor marks should be 0.32 mm (0.0125 in.).

(2) The length of major, intermediate, and minor graduation marks should be at least 5.6 mm, 4.1 mm, and 2.5 mm (0.22, 0.16, and 0.09 in.),

(3) The minimum distance between major graduation marks should be 13 mm (0.5 in.).

(4) Minor graduation marks may be space as close as 0.89 mm 90.035 in.), but the distance should be at least twice the stroke width for white marks on black dial faces and at least one stroke width for black marks on white dial faces.

D. Scale Markings (Low Luminance – below 1 ft–L)

(1) The minimum width of a major graduation should be 0.89 mm (0.035 in.), the minimum width of an intermediate graduation should be 0.76 mm (0.030 in.), and the minimum width of a minor graduation should be 0.64 mm (0.025 in.).

(2) The length of major, intermediate, and minor graduation marks should be at least 5.6 mm, 4.1 mm, and 2.5 mm (0.22, 0.16, and 0.10 in.), respectively.

(3) The minimum distance between major graduation marks should be 16.5 mm (0.65 in.).

(4) Graduation marks should be spaced a minimum of 1.5 mm (0.06 in.) between centerlines.

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APPENDIX D
EXCEPTIONS AND OPEN ITEMS

D.1 TO BE DETERMINED ITEMS

TABLE D–1 TO BE DETERMINED ITEMS

TBD No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
1	The total mass of the attached payload to be attached at the MCAS translated by the MT along the ISS truss must be determined. PEI to solicit Mobile Servicing System Integration panel to task the responsible vehicle team to define the maximum mass capability for MCAS.	3.1.2.3A	R. Turner/ CSA	11/1/99	12/21/01. Allowable mass of AP on MCAS is 19,000 lbs except when Russian docking occurs. The capability of the MCAS is reduced to 10,000 lbs when a Russian docking occurs. Reference PIRN 57003–NA–0026 for requirement modification. MCAS Loads Status presented to CAS Tiger Team on 12/19/01 by Boeing Houston Structures and Mechanisms.
2	Allowable envelope around the active PAS for an attached payload keel trunnion is to be defined. Action 1: Construct UG model of available envelope around active PAS with consideration for EVA access to CLA and UMA ORUs. Action 2: Validate that the envelope provides adequate clearances with MBS components while payload interfaces with MCAS.	Figure 3.1.3.1.1.1–1	C. Bantunek/ Boeing G. Osorio/ Boeing M. Olsen /Boeing	11/1/99 Post DAC8	2/5/02. Allowable envelope developed based on clearance analysis results and CAS Tiger Team review. Reference CAS analysis results in Boeing memo 5–5165–MS–020152.
3	The interface loads for the passive UMA mounting bracket during engagement with the active UMA must be defined.	3.1.3.2.3.1B 4.3.1.3.2.3.1B	J. Leuer/ Boeing	11/1/99	11/11/99. Interface load defined per PIRN 57003–NA–0003A and subsequently incorporated in IRN 0001 on 11/18/00.
4	Define attached payload microgravity requirements: – Microgravity – Limit Quasi–Steady Accelerations – Limit Vibratory and Transient Acceleration	3.1.3.2.6 4.3.1.3.2.6 3.1.3.2.6.1 4.3.1.3.2.6.1 3.1.3.2.6.2 4.3.1.3.2.6.2	C. Schafer/ SAIC	Unknown	4/5/01. Microgravity requirements defined per PIRN 57003–NA–0018A.

TABLE D–1 TO BE DETERMINED ITEMS (CONTINUED)

TBD No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
5	MCAS power system characteristics must be verified to be consistent with those specified in this document or those characteristics defined herein. PEI to solicit the Mobile Servicing System Integration Panel to task the responsible vehicle team to complete this action.	3.2.1	M. Olson/ Boeing	11/1/99	4/5/00. MCAS power interface requirements updated by PIRN 57003–NA–0006B. Subsequently incorporated in IRN 0001 on 11/8/00.
6	Requirement for berthing camera and mounting bracket has not been defined. CR 1550 will determine the berthing cue system to be used by attached payloads for berthing to the S3 PAS, P3 UCCAS, or MCAS sites. Berthing cue system requirement will be incorporated following approval of CR.	3.7.6 4.3.7.6	J. Turner/ CSA	Next rev. pending approval of CR	12/21/01. Requirements for BCS accommodation added in section 3.7.6 (and verification in 4.3.7.6) by PIRN 57003–NA–0026A.
7	Requirement for clearance envelope for an Attached Payload requiring SSRMS support has not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.A	A. Patel/ MDR	6/28/02	
8	Requirement for the structural and mechanical interface for an Attachment Payload requiring SSRMS support has not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.B	A. Patel/ MDR	6/28/02	
9	Requirement for the interface for the PVGF for an Attached Payload requiring electrical power from the SSRMS has not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.C	A. Patel/ MDR	6/28/02	
10	Requirement for providing electrical power for an Attached Payload requiring electrical power from the SSRMS has not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.D	A. Patel/ MDR	6/28/02	

TABLE D–1 TO BE DETERMINED ITEMS (CONTINUED)

TBD No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
11	Requirement for the PVGF interface for an Attached Payload requiring data from the SSRMS has not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.E	A. Patel/ MDR	6/28/02	
12	Requirement for the PVGF interface for an Attached Payload requiring a video interface with the SSRMS has not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.F	A. Patel/ MDR	6/28/02	
13	Requirement for the PVGF harness and connectors for an Attached Payload requiring an electrical interface with the SSRMS has not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.G	A. Patel/ MDR	6/28/02	
14	Requirement for the thermal conductance from an Attached Payload to the PVGF harness and connectors for an Attached Payload requiring an electrical interface with the SSRMS has not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.H	A. Patel/ MDR	6/28/02	
15	Requirements for electromagnetic effects for an Attached Payload requiring SSRMS support have not yet been defined. Will be defined in document SSP 42004.	3.7.3.3.I	A. Patel/ MDR	6/28/02	
16	EBCS thermal requirements have not yet been defined. Macdonald Dettwiler Robotics (MDR) to define requirements for EBCS per Requirements Item Discrepancy (RID) #A1007.	3.7.6.3 4.3.7.6.3	D. Bush/ MDR	6/1/02	
17	Document defining acceptable test methods for microgravity transient requirements is not yet defined	4.3.1.3.2.6.2.2	F.Henderson/ TBE	5/1/02	

D.2 TO BE RESOLVED ITEMS

TABLE D–2 TO BE RESOLVED ITEMS

TBR No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
1	Payload developers have challenged the validity of the defined PAS interface load set claiming the loads are based on a single configuration from a 1994 analysis and do not represent the true as–built capabilities. DAC 8 loads and dynamics analysis will provide PAS interface load forces and moments data for the specific payload complement case – (1) 14,000 lb AMS, (3) 5,000 lb. ExP. Will include docking, reboost EVA, etc. load factors. Report due Jan '99. Follow–up analysis by PAS designers will validate the APIRD interface loads Table 3.1.1.2.3–2.	Table 3.1.1.2.3–2 Table 3.1.1.2.3–3	J.Dutson/ Boeing J.Nelson/ Boeing	3/31/00	12/21/01. Load data revised and confirmed by DAC8 analysis and approved at the Attached Payload Forum. Updated and added tables in PIRN 57003–NA–0026.
2	EVA Kickoff, push–off, kick, bump, and portable foot restraint loads are being assessed during DAC8 to ensure truss and active PAS structure can withstand these loads. Boeing withholds concurrence with these requirements until DAC8 is complete. IRD will be updated consistent with results of DAC8. Addition of new EVA loads will likely require significant coordination with EVA and Robotics projects office to ensure a comprehensive coverage of all EVA and Robotics requirements.	3.1.1.2.6 Table 3.1.1.2.6–1 3.8.1	J.Dutson/ Boeing J.Nelson/ Boeing M.Olson/ Boeing	3/31/00 Post DAC8	3/9/00. DAC 8 completed. Paragraph and Table updated in PIRN 57003–NA–0010A and subsequently incorporated in IRN 0001 on 11/8/00. 11/8/00
3	Payloads anticipate a significant design challenge at meeting the 4,150 lb/in capture bar stiffness requirement. Possible solution for simplifying payload design involves shimming and tight–tolerancing the Capture Latch Assembly be shimmed to a tighter tolerance stack–up.	3.1.3.1.3.2	J.Favero/ Boeing	12/1/99	9/20/01 Requirement modified in PIRN 57003–NA–0024.

TABLE D–2 TO BE RESOLVED ITEMS

TBR No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
4	Payloads have challenged the validity of the magnetic field requirements for attached payloads. EME AIT to investigate magnetic field susceptibility for Station external subsystems (e.g. ORUs, SSRMS, SPDM, EMUs, etc.) with the intent to relax the requirement if possible.	3.2.2.4.6 3.2.2.4.7	J.Leuer	11/1/99	10/24/01. Issue initiated to address concerns regarding the Alpha Magnetic Spectrometer (AMS) magnetic field. An ISS Electromagnetic Effects Panel (EMEP) Tailoring / Interpretation Agreement (TIA), EMEP TIA #0310 was approved on 10/24/01 to allow AMS to pursue an exception to the requirements.
5	Payload developers do not concur with this requirement. PEI to organize a Thermal Technical Interchange Meeting between vehicle thermal experts and payloads to derive a valid set of requirements. Payloads will also determine limits on amount of reflected energy they can stand from neighboring payloads.	3.4.1.1.3 4.3.4.1.1.3	M.Olson/ Boeing G.Cook/ NASA	11/1/99 12/15/99	5/3/01. PIRN 57003–NA–0017C added paragraphs to require delivery of thermal models to ISS program and clarify requirements between payloads. PIRN 57003–NA–0026 on 12/21/01 subsequently deleted paragraphs 3.4.1.1.2, 3.4.1.1.3, 3.4.1.1.4 and all associated verification.
6	Payload developers do not concur with this requirement. PEI to organize a Thermal Technical Interface Meeting between vehicle thermal experts and payloads to derive a valid set of requirements. Payloads will also determine limits on amount of thermal energy they can absorb from neighboring payloads.	3.4.1.1.4 4.3.4.1.1.4	M.Olson/ Boeing G.Cook/ NASA	11/1/99 12/15/99	5/3/01. PIRN 57003–NA–0017C added paragraphs to require delivery of thermal models to ISS program and clarify requirements between payloads. PIRN 57003–NA–0026 on 12/21/01 subsequently deleted paragraphs 3.4.1.1.2, 3.4.1.1.3, 3.4.1.1.4 and all associated verification.

TABLE D–2 TO BE RESOLVED ITEMS

TBR No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
7	Attached Payload developers contend the external contamination requirement for molecular deposition (i.e., $5x10^{-15}$ $gm/cm^2/sec$ and $1x10^{-15}$ $gm/cm^2/sec$) is too tight and unverifiable. Attached Payload Forum and External Contamination Team to meet to determine how requirement can be modified or a process defined to satisfy all parties.	3.5.1.5.2A 4.3.5.1.5.2A 3.5.1.5.2B 4.3.5.1.5.2B	M.Olson/ Boeing G.Cook/ NASA	12/1/99	11/8/00. Requirement modified in PIRN 57003–NA–0001C and subsequently incorporated in IRN 0001.
8	Keep–alive heater power for the EBCS avionics package is currently specified at 25W. This value is dependent upon the EBCS thermal requirements. The EBCS thermal requirements will be defined as part of TBD #16 resolution.	3.7.6.2	D.Bush/ MDR	6/1/02	7/31/02. Keep–alive heater power for the EBCS avionics package confirmed to be 25W at the EBCS SDR 7/30 – 7/31/02.
9	EBCS avionics package vibration limits specified in table were challenged by attached payload developers at the MDR EBCS Avionics System Requirements Review per RID # Thoren 8. The table needs to be updated in the EBCS documentation so that the limits specified may be updated in this document.	3.7.6.4–1	D.Bush/ MDR	6/1/02	7/31/02. EBCS avionics package vibration limits table in the EBCS IDD were updated and presented at the EBCS SDR 7/30 – 7/31/02.
10	Payloads have challenged the method used to determine interface preload and stiffness requirements necessary to prevent gapping. Boeing–HB to assess with integrated analysis.	3.1.3.1.3.1 3.1.3.1.3.2	M.Mehrinfar/ Boeing	4/25/02	4/29/02 BHB performed integrated analysis with AMS model. Results indicate current stiffness is adequate, but that reaction points need to be defined.

TABLE D–2 TO BE RESOLVED ITEMS

TBR No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
11	Boeing to evaluate if current requirement is sufficient to prevent gapping between active and passive UMA.	3.1.3.2.3.1.C	J.Scheerer/ Boeing	4/2502	
12	Further evaluation required to assess the ability to achieve a Class R bond at the fully seated guide pin/guide vane interface.	3.2.2.4.2 4.3.2.2.4.2	V. Sanders/ C. Young/ Boeing	8/1/02	7/25/02 The CAS Interface Class R Boding Test documented in test report MDC 02H1044 indicates that a class R bond is achievable through the CAS interface based on the guide pin and interface design defined in SSP 57003 and SSP 57004.

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